Public Health England

Protecting and improving the nation's health

Risk factors for gambling and harmful gambling: an umbrella review

A review of systematic reviews and meta-analyses

Contents

Abbreviations

ADHD	Attention deficit hyperactivity disorder
AMSTAR	Assessing the Methodological Quality of Systematic Reviews
CERQual	Confidence in the Evidence from Reviews of Qualitative Research
CoI	Conflict of interest
DCMS	Department for Digital, Culture, Media and Sport
DSM	Diagnostic and Statistical Manual
EPPI-Reviewer	Evidence for Policy and Practice Information Reviewer
IPV	Intimate partner violence
MA	Meta-analysis
NICE	National Institute for Health and Care Excellence
OECD	Organisation for Economic Co-operation and Development
PGSI	Problem Gambling Severity Index
PICO	Population, Intervention, Comparison, Outcome
PICO-S	Population, Issue, Comparison, Outcome, Study Type
PHE	Public Health England
PRISMA-P	Preferred Reporting Items for Systematic Review and Meta-Analysis Protocols
PROSPERO	The International Prospective Register of Systematic Reviews
PTSD	Post-traumatic stress disorder
SOGS	South Oaks Gambling Screen

You can find a full list of definitions and technical terms in the Gambling Glossary.

Executive summary

Background

The harms associated with gambling are increasingly recognised as a public health issue. According to the most recent Health Survey for England (2018) more than half of the general population aged 16 and over in England had participated in gambling in the previous 12 months. The potential harms associated with gambling are broad, including harms to individuals, their friends and family, and society. There is a need to better understand the nature of this issue, especially the determinants of harmful gambling.

This report is part of a broader review examining gambling-related harms in England set out in Public Health England's remit letter for 2018 to 2019. The purpose of this study was to identify and examine the risk factors associated with gambling and harmful gambling.

Methodology

We conducted an umbrella review, where we used systematic methods to identify, appraise and synthesise systematic reviews and meta-analyses of possible risk factors for gambling and harmful gambling. We conducted searches on 4 September 2019, then updated on 10 July 2020. We included systematic reviews and meta-analyses if they were published between 1 January 2005 and 8 July 2020, were in the English language, and were focused on any population, any possible risk factor and all types of gambling (land-based and online) (see Table 1). The systematic reviews included a range of quantitative studies (such as experimental, cross-sectional and longitudinal) as well as qualitative studies. Reviews examining prevalence of gambling and co-morbidities were excluded.

We conducted electronic searches in Ovid Medline, Ovid Embase, Ovid PsycInfo, NICE Evidence and SocIndex via EBSCO, and searched a range of websites for relevant literature not published in academic journals. We scanned reference lists and contacted experts to identify additional papers. Two reviewers independently did the screening, quality assessment and data extraction. We assessed the quality of included reviews using AMSTAR 2, and used data extraction tables to extract standard information from each study. This included results relevant to potential inequalities, which we extracted where they were available. We used a narrative synthesis to summarise the results, themed using the socio-ecological model which included societal level, community level, family and social level, and individual level factors. We used the principles of GRADE CERQual to determine confidence in the available evidence related to potential risk factors.

Results

We screened 4,008 references (including 186 full text articles) in duplicate and 39 systematic reviews were included in the review. This included:

- 20 narrative synthesis only
- 15 meta-analysis only
- 4 with narrative synthesis and meta-analysis

Reviews included studies of different populations, from different countries and different types of gambling. Most of the primary studies reported in the reviews were cross-sectional, with only 5 reviews reporting on longitudinal studies (see Table 2). Except for one, the quality of all reviews was scored as 'critically low' using AMSTAR 2. Most described a satisfactory literature search, but the majority (35 reviews) had not assessed the risk of bias of included studies and few (6 reviews) reported having a protocol. Eight reviews did not include any conflict of interest statement and the funding for 13 of the 40 reviews was not reported on (see Table 3).

We identified 45 potential risk factors, which are all set out in the main report. We examined:

- 4 in relation to gambling
- 25 in relation to harmful gambling
- 15 factors in relation to both gambling and harmful gambling

The majority (33 risk factors) were individual-level factors such as income and genetics. The remainder were family or social (5 factors), community (4 factors) and societal (3 factors).

Fourteen of the reviews included only quantitative studies, 2 included only qualitative studies, 7 included both qualitative and quantitative studies, and for 16 it was unclear. One high quality systematic review with a meta-analysis examined potential risk factors for harmful gambling which focused on children and young people. This review identified 15 risk factors based entirely on longitudinal studies. All other reviews focused on one or more potential risk factors and included a limited amount of longitudinal evidence.

The lack of longitudinal evidence, and the lack of risk of bias assessment of studies which were in included the reviews, meant that for many risk factors it was not possible to make firm conclusions that they were risk factors for gambling or harmful gambling. We have been clear when we could not confirm causality for this reason.

We could not identify any factors that influence gambling with a high or moderate degree of confidence. However, we had a high degree of confidence that impulsivity, substance

use (alcohol, tobacco, cannabis and other illegal drugs), being male and having depression could be risk factors for harmful gambling among children and young people.

We had moderate confidence that there could be a further 6 risk factors for harmful gambling among children and young people. These were:

- number of gambling activities they participated in
- problem gambling severity
- anti-social behaviour
- being violent
- poor academic performance
- peer influence

We also had moderate confidence that a further 8 were not risk factors for harmful gambling in children and young people. These included:

- money won or lost
- risk taking
- age and age of starting gambling
- religion
- aggression
- dispositional attention (see Glossary)
- some mental health problems (specifically anxiety, psychological distress, suicidal ideation and negative affect (see Glossary))

We had low confidence that 10 factors could be considered risk factors for gambling, including ethnicity and impulsivity. We also had low confidence about a further 14 factors for harmful gambling, including personal relative deprivation and trauma. Our low confidence was due in part to methodological limitations (for example, most studies in the review were cross-sectional) despite some having large numbers of studies. For other factors, including risk perception or family influences, we had very low confidence in the evidence or there was insufficient evidence to determine whether or not a factor might be a risk factor for gambling or harmful gambling.

The reviews we included had defined and assessed harmful gambling in different ways, so it was not possible to determine how potential risk factors affect the extent of harmful gambling. There was also limited evidence on potential inequalities with the exception of age and gender.

Discussion and conclusion

There is a large body of evidence describing factors associated with harmful gambling. There is stronger evidence across a range of risk factors for children and young people,

due to a recent high quality systematic review and meta-analysis which identified all potential risk factors for this population group, based on longitudinal studies. A similar piece of work needs to be conducted for adult populations, because the available review-level evidence is largely based on cross-sectional studies.

Our review identified a large number of available systematic reviews and meta-analyses. But usefulness of these is limited because they have no risk of bias assessment of included studies and rely on cross-sectional studies. These reviews do suggest associations between possible risk factors and harmful gambling, but we need longitudinal studies to estimate the nature and strength of causal effects. So, there needs to be a full systematic review of longitudinal studies, which examines risk factors for harmful gambling in the adult population, and of longitudinal studies into environmental and societal influences on all age groups.

Despite these limitations, this report provides important insights into factors that could be important contributors to gambling and harmful gambling. Anyone who is developing interventions to prevent harmful gambling should carefully consider the factors we have identified.

1. Introduction

1.1 Gambling: a public health problem

The harm caused by gambling is increasingly being identified as a public health problem (1, 2). Harms associated with gambling are wide-ranging, and affect not only the individual gambler but also their families and close associates, as well as wider society (3, 4). Global prevalence of problem gambling has been reported to range from 0.7% to 6.5% and studies from across Europe have reported high participation in gambling (5).

In 2018, a survey conducted in England by the Gambling Commission reported that almost half of respondents had participated in gambling in the 4 weeks before being surveyed (6). The Health Survey for England (HSE) found similar results in the same year, with 54% of adults reporting engaging in some form of gambling in the last 12 months (7, 8). It also found that 0.7% of respondents were classified as 'problem gamblers' and 1.1% of respondents were classified as 'moderate risk' gamblers (defined as 'those who experience a moderate level of problems leading to some negative consequences') (6).

To be considered a 'problem gambler' in the HSE a person has to score 8 or more on the Problem Gambling Severity Index (PGSI) (9) or have 3 or more symptoms from the Diagnostic and Statistical Manual of Mental Disorders IV (DSM-IV) (10). This threshold is quite high, so the number of people experiencing harmful gambling is likely to be higher than the number of problem gamblers reported in the HSE.

Risk factors are traits or exposures that increase the possibility that a person will develop a condition (11). Possible risk factors for gambling or harmful gambling are broad and have been reported in many systematic reviews and primary studies. Risk factors include (but are not limited to):

- fixed biological characteristics and personality traits such as genetics
- behavioural factors such as, excessive use of alcohol and violent behaviour (12)
- broader factors related to the family environment (13)
- wider community or societal factors such as gambling availability and advertising (14)

We identified several systematic reviews and meta-analyses of risk factors for gambling participation or problem gambling through a scoping search. These largely focused on specific risk factors or types of risk, although one focused on specific populations (15). We did not identify any systematic reviews, meta-analyses or umbrella reviews examining all risk factors for all populations. To understand the breadth of possible risk factors related to gambling and harmful gambling, we need to collate this review-level evidence.

This work is part of a broader review examining gambling-related harms in England (16). In March 2018, then Health Minister Steve Brine wrote the Public Health England (PHE) remit letter confirming PHEs priorities for 2018 to 2019. This included a request for PHE to "inform and support action on gambling-related harm as part of the follow up to the Department for Digital, Culture, Media and Sport-led (DCMS) review of gaming machines and social responsibility" (17). In May 2018, DCMS published their response to the consultation on proposals for changes to gaming machines and social responsibility measures. In it they announced that "PHE will conduct an evidence review of the health aspects of gambling-related harm to inform action on prevention and treatment" (18).

1.2 Aim and research questions

The overall aim of this review is to identify the risk factors associated with gambling and harmful gambling. The research questions are as follows:

1 What risk factors are associated with gambling?
2 What risk factors are associated with different levels of gambling intensity?

For this review, 'gambling' is defined (as set out by the Gambling Act 2005) as "…any kind of betting, gaming or playing lotteries. Gaming means taking part in games of chance for a prize (where the prize is money or money's worth), betting involves making a bet on the outcome of sports, races, events or whether or not something is true, whose outcomes may or may not involve elements of skill but whose outcomes are uncertain and lotteries (typically) involve a payment to participate in an event in which prizes are allocated on the basis of chance" (19). Where we refer to 'gambling' throughout this review, it includes gambling initiation and non-problematic gambling participation in any of the activities described in the definition above.

There is no single agreed term or definition for the level of gambling participation that causes harm. Until recently 'problem gambling', 'pathological gambling' or 'gambling disorder' were the most generally used terms. But these tend to focus on people that meet certain criteria to be clinically diagnosed with gambling addiction, which excludes people experiencing lower levels of gambling-related harm (20, 21). We will use the term 'harmful gambling' in this report to capture the broader group of people experiencing lower levels of harm from gambling as well as those who meet the criteria for a clinical diagnosis for gambling disorder.

This review will include studies that define harmful gambling in different ways, for example, according to screening tools such as the DSM-IV (10), the Diagnostic and Statistical Manual of Mental Disorders V (DSM-V) (22) and the Problem Gambling Severity Index (PGSI) (9). The DSM-IV contains 10 diagnostic criteria for pathological

gambling, and possible scores are between 0 and 10. A score of 3 or more indicates problem gambling. A new edition of the DSM, the DSM-V, has recently been published, reclassifying the condition as ‘gambling disorder’ with possible scores between 0 and 9. The PGSI contains 9 diagnostic criteria, with a possible score of between 0 and 27. A score of 1 to 2 is ‘low risk’, 3 to 7 is ‘moderate risk’ and 8 or more is ‘problem gambling’.

The World Health Organization defines a risk factor as “any attribute, characteristic or exposure of an individual that increases the likelihood of developing a disease or injury” (23). In the context of this review, a risk factor is a factor investigated as being associated with gambling (including initiation, escalation, urge and intensity), or harmful gambling, either causally or otherwise. We aimed to identify all possible risk factors by looking broadly at the evidence base, including evidence that shows cause and effect but also considering evidence that shows associations. In presenting the results we clearly differentiate the evidence that shows the link between the risk factor and gambling or harmful gambling to be causal from the evidence that shows an association.

1.3 Conceptual model

We framed this work within a socio-ecological model to allow us to consider a wide range of potential risk factors at multiple levels. This model is underpinned by the theory that a person’s health and related behaviours are affected and changed by their immediate relationships, their environment and by broader social, political and economic conditions (24).

The socio-ecological model was used to conceptualise the potential risk factors for harmful gambling, drawing on those developed by others in gambling-related work (15) (4) (25). This acknowledges that risk factors may exist at the individual level, but wider factors may also drive gambling behaviour. Below, we have described the potential risk factors based on this conceptual model. As with all socio-ecological models, the influences at each level are not mutually exclusive and may overlap.

Individual

These include biological characteristics, behaviours, exposures, life experiences and personal history that increase the likelihood of experiencing gambling-related harms.

Due to the anticipated volume of studies in this area, we adapted the model slightly by breaking down the individual level into 2 types of risks. ‘Distal’ risks are those that lie in the background and have a formative influence early on in someone’s life, before they start gambling or before their gambling became more severe. Some of these distal risks are fixed and do not change with either time (time-invariant) or other measures (non-modifiable), such as a person’s ethnicity. However, some distal risks can vary with time (time-varying) and may be modified by interventions, such as a person’s coping styles.

Then there are ‘proximal’ risk factors, such as a person’s employment status, that can act alone or with distal risk factors to influence gambling initiation (if it has not started) or an escalation in gambling. These may also be modified by interventions.

Family and social

This is a person’s closest social circle, including family members, peers, teachers, workmates, and other close relationships that contribute to their range of experience. This level includes, for example, parental and peer gambling.

Community

The settings in which social relationships occur, such as schools, workplaces and neighbourhoods. This level includes, for example, access to gambling venues.

Societal

Broad societal factors such as social and cultural norms, as well as health, economic, educational and social policies that contribute to economic and social inequalities between populations. This level also covers corporate influences including industry practices, for example, marketing and advertising.

2. Methodology

This review adopted a rapid review methodology (26) to identify, appraise and synthesise systematic reviews and meta-analyses; generally known as an ‘umbrella’ review (27). Using existing systematic reviews and meta-analyses allowed us to broadly examine the best available evidence in a timely way. It was also useful for addressing the high-level questions set out for this review, where we expected to identify multiple risk factors. We conducted (and reported) this review in accordance with the PRISMA (Preferred Reporting Items for Systematic reviews and Meta-analyses) 2009 guidelines for reporting reviews (28). We developed the protocol before we started the review. It is registered on PROSPERO (CRD42019151520) and also published (29). The review team discussed any deviations to the protocol before implementing them. We documented any deviations in a decision log and report these changes in Appendix A. We conducted the review using EPPI Reviewer-4 software.

2.1 Inclusion and exclusion criteria

Inclusion and exclusion criteria were developed using an adapted version of the PICO (population, intervention, comparison, outcome) framework, as set out below in Table 1. Initial scoping work informed the methodology. This work involved searching various sources to find studies about the risk factors for harmful gambling, using generic gambling terms and general terms such as ‘risk or risk factors and determinant*'.

Table 1: PICO-S

Population	We included all populations. This included adults and children, general population, sub-groups of the population (for example by sex, age, ethnicity, geographical location, deprivation, institution) or a clinical population (for example those with Parkinson's disease, post-traumatic stress disorder).
Issue	Risk factors associated with gambling and harmful gambling. we included all risk factors. This included individual and clinical attributes (such as age, impulsivity and the presence of Parkinson's disease), as well as social and environmental factors (such as family influences, the availability of gambling and advertising). We excluded reviews of studies examining protective factors.
Comparison	We included studies with any or no comparisons. Non-problem gamblers, healthy population, general population, sub-groups of gamblers.
Outcomes	We included all forms of gambling (land-based and online), including gambling-related aspects of gaming and different levels of gambling. Gambling initiation, urges and escalation.
Study type	We included systematic reviews of both quantitative and qualitative studies, including cross-sectional, longitudinal (cohort, case-control) experimental, quasi-experimental, gene association studies, with narrative synthesis and meta-analysis. During screening, a systematic review was more formally defined if it met at least 4 of 5 Database of Abstracts of Reviews of Effects (DARE) criteria (30) with criteria 1 to 3 being mandatory: 1 Were inclusion and exclusion criteria reported? 2 Was the search adequate? 3 Were the included studies synthesised? 4 Was the quality of the included studies assessed? 5 Are sufficient details about the individual included studies presented? We excluded other review types such as mapping, scoping and narrative reviews. We also excluded reviews of studies examining the effectiveness of interventions.

2.2 Additional inclusion criteria

Language

We only included studies in English. Other languages were not included due to the team's inability to translate.

Publication date

We included studies from 1 January 2005 to 8 July 2020. This was because 2005 was the year the Government issued proposals to reform the law on gambling (the Gambling Act) and the Economic and Social Research Council in partnership with Responsibility in Gambling Trust provided £1 million of funding for research on problem gambling. This significantly increased capacity for research on this topic in England (31) and so the number of studies published on this issue increased.

Publication type

We included peer reviewed and grey literature[1].

Setting

We included reviews of studies that are based within the Organisation for Economic Co-operation and Development (OECD) using a list of OECD member countries. This ensured the findings were applicable to the UK setting. For reviews set in non-OECD countries, more than half of included studies needed to be from OECD countries to be included. Inclusion or exclusion of these was considered on a case-by-case basis. During screening we decided to include clinical papers (for example, those that included genetic, biological and psychological traits as risk factors) even if it was unclear whether the included papers were from OECD countries or not (see Appendix A for deviations from the protocol).

2.3 Search strategy

We undertook a comprehensive search using multiple methods to identify both published and grey literature. The search strategy was developed by a senior information scientist in PHE and shared with a second information scientist in PHE. We performed an initial search on 4 September 2019 for search dates 1 January 2005 to 4

[1] Relevant literature not published in academic journals

September 2019. We performed an updated search on 10 July 2020 for search dates 3 September 2019 to 8 July 2020. We used the same search strategy for both searches.

Electronic searches

The databases we searched were:

- Ovid Medline
- Ovid Embase
- Ovid PsycINFO
- NICE Evidence
- SocIndex via EBSCO

We recorded the number of papers retrieved from each database. You can see the full Medline search in Appendix B. This was adjusted for use in other databases. The search looked for terms in the title, abstract, author key words and thesaurus terms (such as MeSH, Medical Subject Headings) in Medline, where available. The review filter was used for all databases except for SocIndex (which does not have a validated filter). For SocIndex, a set of search terms was created to restrict the search to reviews.

Grey literature

We searched for reports and other relevant literature that may not have been published in databases, using Google and a range of gambling-related websites or appropriate study registries for years 2005 to 2020 (see Appendix C for the full list). We did this using a range of key words. If a website provided a review summary, we tried to find the full study report.

Handsearching

We searched the reference lists of included studies for additional relevant papers that fulfilled the inclusion criteria. We also searched the reference lists of any reviews of reviews we identified.

Consultation with experts

Once a list of included studies was available, it was shared with the project expert reference group to check for additional studies. This group included national and international topic experts.

We recorded the number of papers retrieved from each database. We downloaded the results into the EndNote reference management program (version X8) (32) and removed any duplicates. The references were then imported into EPPI Reviewer software (33).

2.4 Screening and selecting reviews

We undertook a pilot screen where each reviewer independently screened the same 100 randomly selected references and indicated which reviews should be included or excluded. Reviewers obtained the full paper if this was needed for them to make their assessment. Any discrepancies showed inconsistencies in understanding of the inclusion and exclusion criteria between reviewers. These discrepancies were identified, discussed and resolved. The inclusion and exclusion criteria were modified as necessary, and the changes recorded in a decision log.

The references were divided equally between 4 reviewers. The title and abstract of every reference was screened independently by 2 reviewers ('review pairs') according to the inclusion and exclusion criteria, and each reference was coded as either 'included' or 'excluded'. We used EPPI Reviewer to measure the level of agreement between reviewers in review pairs. Agreement of 90% or more was considered acceptable in line with guidance from the National Institute for Health and Care Excellence (NICE) on title and abstract screening (34). A third person was consulted to resolve any disagreements and achieve a final consensus on which reviews to include.

The full papers of the remaining references were divided between reviewers and screened independently using inclusion and exclusion codes set up in advance by the review team. Twenty percent of the papers screened by each reviewer were reviewed independently by a second reviewer using the 'parent' codes 'include' and 'exclude' (that is, rather than specific exclusion codes such as 'date', 'setting', 'study type'). Agreement levels were calculated using EPPI reviewer. A threshold of 80% agreement was considered acceptable in line with quality criteria outlined in the AMSTAR 2 assessment tool (35) (NICE guidelines on reviewing do not provide a measurable threshold for this stage of screening).

When screening the results of the first search, only 75% agreement was achieved. So, we decided to double screen all full text papers after further clarifying the inclusion and exclusion criteria, particularly the definition of a systematic review (see Appendix A for changes to the protocol). This led to 95% agreement overall (91% minimum within pairs). A third person was consulted to resolve any disagreements. We adopted the same approach for the second search (screening and study selection in full duplicate). An agreement of 95% was achieved for the title and abstract screening and 89% for full text screening.

For the grey literature, 2 reviewers independently screened all the references using the same inclusion and exclusion codes used for the peer reviewed literature. A third person was consulted to resolve any disagreements.

Two reviewers searched the reference lists of the final set of papers (peer reviewed and grey literature) for relevant papers using the relevant inclusion and exclusion codes. A third person was consulted to resolve any disagreements. The final list of references was sent to the expert reference group who were asked whether they knew of any additional papers relevant to the topic. The expert reference group's role was to inform and guide the review team undertaking the review. The papers were then assessed against the inclusion and exclusion codes by 2 reviewers with reference to a third person as necessary.

2.5 Data extraction

We used data extraction tables to extract the relevant information from each study. The information extracted included:

- authors
- date
- aim
- setting
- the PICO-S elements
- details of the included studies (date range, sources and type)
- synthesis method
- relevant results (including dimensions of inequality)
- funding source
- limitations

Data extraction tables were pilot tested before being used and signed off by the expert reference group. All 4 reviewers extracted the data independently from a set of eligible reviews using EPPI reviewer. Ten percent of all papers were randomly selected and the data from these was extracted independently by a second reviewer. A third person was consulted to resolve any disagreements. Agreement between reviewers for data extraction was assessed using the reconciliation facility within EPPI reviewer. The minimum acceptable agreement level was 80% (35) and this was achieved. We used the Cochrane PROGRESS-Plus tool (36) to extract data on the broad dimensions of inequality.

2.6 Quality assessment (risk of bias)

We assessed the quality of systematic reviews using the AMSTAR 2: (A MeaSurement Tool to Assess Reviews) (35), which assesses potential bias in reviews based on core aspects of its methods including the search, screening and extraction, risk of bias assessment and synthesis of included studies. We used the recommended rating process to classify reviews as high, low or critically low according to the numbers of

critical and non-critical weaknesses identified. The tool was not used to provide an overall score, as this risked disguising critical weaknesses across different domains.

We pilot tested AMSTAR 2 to ensure all reviewers were using it consistently and made 2 changes as a result. First, we changed item 7 ('Provide a list of excluded reviews and justifications') from critical to non-critical as, given the recent development of the tool, we expected few reviews to provide this level of detail.

Secondly, we changed item 16 ('Conflict of interest, CoI') from non-critical to critical. Given the topic of this review this information would help increase confidence in the review findings. To score a 'yes' for this item on AMSTAR 2, the authors had to report either:

- no competing interests
- their funding sources and the successful management of potential conflict of interest

To score a 'no' the authors had to report either:

- a competing interest with no explanation of managing the potential conflict from this
- no declaration of conflict of interest included in the paper

We used the following categories to report on funding:

1 Direct industry funded: the researchers name a gambling industry company or an industry trade organisation.
2 Indirect industry funded: funding was via a levy, or via a charity that relies fully on industry funding or a regulatory settlement.
3 Not industry funded.
4 Co-funded: funding came from multiple sources. We listed if the funding came directly from industry, indirect from industry or from a non-industry source where possible.
5 Funding unknown.

Each review was independently assessed by 2 reviewers, disagreements were resolved through discussion and any discrepancies were resolved by a third person.

2.7 Method of synthesis

Given the reviews included in our review were very different from each other, we used a narrative (descriptive) synthesis with text to summarise and explain the findings (37). We developed a risk factors codebook using an iterative process but starting with the conceptual model set out previously.

We put together an initial list of potential risk factors for gambling from papers sourced during the scoping search (25, 38, 39) and allocated them to the levels within the conceptual model. We added more risk factors to this list throughout the data extraction process to ensure that all possible risk factors were captured. This list was then checked and agreed by the expert reference group.

We summarised the reviews according to risk factors and included an appraisal of the quality of the literature. We examined the differences by sub-group where this was reported in the literature to integrate a focus on equity (36). In considering the body of evidence, we considered the 4 principles laid out in the CERQual approach. These are:

- the methodological limitations of the studies which make up the evidence
- the relevance of findings to the review question
- the coherence of the findings
- the adequacy of data supporting the findings (40)

3. Results

3.1 Search results

The initial electronic literature search found 4,483 references that could possibly be included in the review. A further 135 references were identified using other sources. One hundred were identified from grey literature searches, 27 from checking reference lists of the final set of papers and eight by consulting with experts in the field. This left 3,628 references after duplicates were removed. The second search identified an additional 380 references. We downloaded all references into an Endnote database and any duplicates were removed before importing into the systematic review software EPPI reviewer. A total of 4,008 references were screened in duplicate and 186 full text papers assessed for eligibility (3,822 were excluded). Five reviews were excluded at write-up stage. Thirty-nine eligible systematic reviews and meta-analyses (MAs) remained and were included in the review (Figure 1). You can find a list of all excluded papers, with reasons, in Appendix D.

3.2 Characteristics of included reviews

Thirty-nine systematic reviews were included in the review, of which 20 were narrative synthesis only, 15 were meta-analyses only and 4 conducted both narrative synthesis and meta-analyses. Fourteen of the reviews were quantitative, 2 were qualitative, 7 were both quantitative and qualitative, and for 16 of the reviews it was unclear whether they were quantitative or qualitative. Table 2 shows the characteristics of the included reviews.

The reviews were published between 2008 and 2020 and the included studies were published between 1983 and 2019. The number of primary studies in each review ranged from 8 to 70. Most of the included primary studies were cross-sectional and only 5 reviews included longitudinal evidence (13,41-43,59). The rest consisted of case-control, experimental, quasi-experimental, qualitative, gene association studies or lacked clarity on study type.

The reviews covered different populations (children and young people, adults, older adults, migrant populations and vulnerable groups), settings (schools, clinical, community) and countries (mostly US, Canada, Australia, New Zealand and Europe). It is not possible to accurately provide full details on the population, country or study types of all the included studies. This is because many of the reviews did not provide detailed descriptions and results were often described briefly in narrative format without any further information. Many of the reviews included a separate section on risk factors as part of a much broader review.

To note: we use the term ‘gender’ in this review as this term was used in included studies. It was often used interchangeably with sex.

3.3 Duplicate primary studies

There were 77 duplicate primary studies across 30 of the included reviews. Fifty-seven studies appeared in the references of 2 of the included reviews, 15 studies appeared in 3 of the included reviews, 3 studies were referenced in 4 reviews and 2 studies were referenced in 5 reviews. As a result, where numbers of included studies are presented in this review, there will be some double counting. You can find a list of the duplicate studies, in Appendix E.

Figure 1: PRISMA flow diagram for risk factors associated with gambling and harmful gambling umbrella review

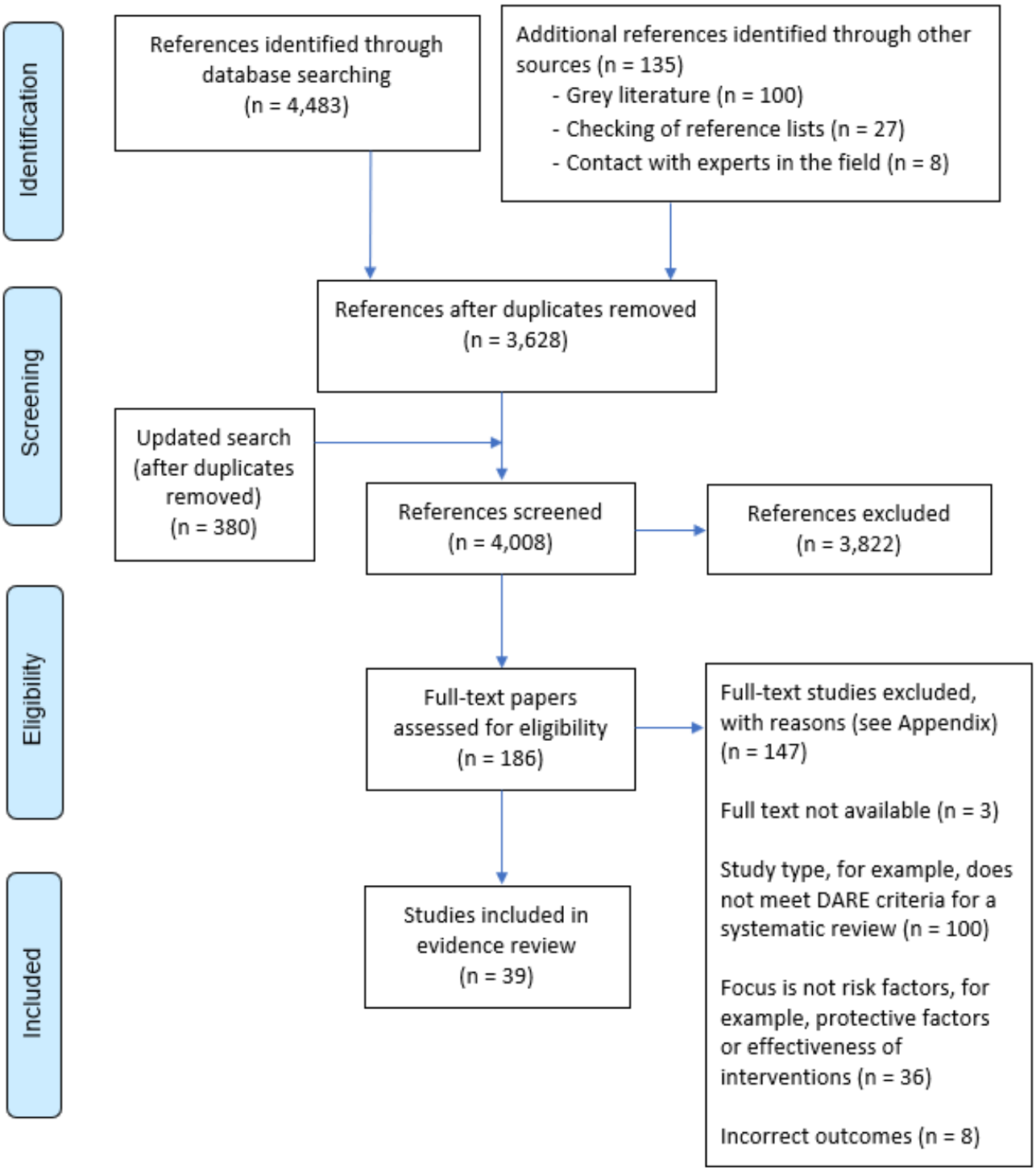

Table 2: Characteristics of included reviews

Author, Year (Method of synthesis) Risk of bias rating	Aim / Research question	Study population, Setting, Country, Number and date range of included studies	Study type and number	Outcome(s)	Conflict of interest (CoI) / Funding source declared	Summary of key findings	Risk factor level*
Amlung, 2017 (44) meta-analysis (MA) only) AMSTAR 2 rating critically low	1: To investigate continuous associations between delayed reward discounting and addiction-related variables, including psychoactive drugs and gambling behaviour 2: To examine potential moderators of effects across studies 3: To examine the influence of publication bias on the aggregate findings	Study population and setting not specified **64 studies:** Countries and date range not specified	Not specified (64)	Problem gambling, pathological gambling	No CoI declared Funding unknown	**Meta-analysis:** Consistent association between delay reward discounting and addictive behaviour overall, albeit of relatively small effect size magnitude and high levels of heterogeneity. **Subgroup analyses**: None	5
Bouguetta ya 2020 (43)	To examine the evidence on the relationship between gambling advertising and gambling-	Adults and children Setting not specified	Longitudinal (1); experimental (1); quasi-	Gambling-related attitudes, intentions	No CoI declared	**Meta-analysis**: Positive association found between exposure to gambling advertising and gambling-related attitudes,	1

Author, Year (Method of synthesis) Risk of bias rating	Aim / Research question	Study population, Setting, Country, Number and date range of included studies	Study type and number	Outcome(s)	Conflict of interest (CoI) / Funding source declared	Summary of key findings	Risk factor level*
(MA only) AMSTAR 2 rating critically low	related attitudes, intentions, and behaviours	**28 studies:** Australia (15); Germany (1); Canada (2); Norway (2); USA (4); Sweden (2); New Zealand (1); Hong Kong (1) Published 2000-2019	experimental (3); cross-sectional (23)	and behaviour	Not industry funded	intentions and behaviour. Association greatest for gambling behaviour. There was some evidence for a dose-response relationship. **Sub-group analysis:** None	
Callan, 2015 (45) (MA only) AMSTAR 2 rating critically low	1: To determine the relationship between personal relative deprivation and gambling urges among people reporting recent gambling experience 2: To determine whether this relation is moderated by problem gambling severity	Study population not stated, however table 1 shows young people and adults; community or university samples **8 studies:** countries not specified Published 2008-2012	Cross-sectional (8)	Problem gambling severity and gambling urges	No CoI declared Not industry funded	**Meta-analysis:** Positive associations found between personal relative deprivation and gambling urges (Random Effects, 0.261, Z = 6.43, p <.0001; Fixed effects: r = .263, Z = 7.78, p <.000). **Moderator analysis:** Results were moderated by problem gambling status: stronger relationship at higher levels of problem gambling severity. **Subgroup analysis**: none	4

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Chowdhury, 2017 (46) (Narrative and MA) AMSTAR 2 rating critically low	To assess whether problem gamblers without comorbid substance use disorder have elevated motor impulsivity, relative to healthy controls	**General population** Setting not specified **20 studies:** Countries and date range not specified	Experimental (20)	Problem gambling without comorbid substance use disorder	No CoI declared Funding unknown	**Narrative review:** The authors describe what each of the 20 studies included in the MA reported, for example, 5 studies reported stop signal reaction time differences (with a total of 179 problem gamblers and 188 Controls) 4 of which involved choice reaction time tasks; 7 studies reported Go/No go Commission Differences (n=328 problem gamblers, n=350 controls). **Meta-analysis**: Elevated motor impulsivity was identified in problem gamblers without comorbid substance use disorder (specific substance unreported). **Subgroup analysis:** None	5

Author, Year (Method of synthesis) Risk of bias rating	Aim / Research question	Study population, Setting, Country, Number and date range of included studies	Study type and number	Outcome(s)	Conflict of interest (CoI) / Funding source declared	Summary of key findings	Risk factor level*
Dowling, 2016 (12) (Narrative and MA) AMSTAR 2 rating critically low	1. To conduct meta-analyses to identify the mean prevalence of intimate partner violence (IPV) victimisation and perpetration in problem gambling samples; 2. To identify the factors that may influence the relationship between problem gambling and IPV victimization and perpetration.	**Adults; Children; Young People** Recruited from any source **14 studies:** Australia (1); Canada (2); New Zealand (2); Spain (1); United States (8) Most studies published 2006 -2012	Cross-sectional (14)	Any lifetime or current measure of gambling or problem gambling	No CoI declared Not industry Funded	**Narrative review:** Factors that could be implicated in the relationship between problem gambling and IPV victimisation included less than full employment and clinical anger problems. Younger age, less than full employment, clinical anger problems, impulsivity, and alcohol and substance use (including illicit drug use), are implicated in the relationship between problem gambling and IPV perpetration. **Meta-analysis:** Authors reported a weighted mean effect of 38.1% for physical IPV victimisation in problem gambling samples (for example, over a third of problem gamblers report being victims of physical IPV), 36.5% for physical	3

Author, Year (Method of synthesis) Risk of bias rating	Aim / Research question	Study population, Setting, Country, Number and date range of included studies	Study type and number	Outcome(s)	Conflict of interest (CoI) / Funding source declared	Summary of key findings	Risk factor level*
						IPV perpetration in problem gambling samples, and 11.3% for problem gambling in IPV perpetration samples. **Subgroup analysis:** see narrative review above. Also, relationship between problem gambling and IPV perpetration associated with younger age. Inconsistent findings relating to gender.	
Dowling, 2017 (15) (Narrative and MA) AMSTAR 2 rating high	1:To provide an up-to-date overview of existing research designed to identify early risk and protective factors longitudinally associated with the development of gambling problems 2: To provide a narrative	**Children and young people** School; population; community Narrative review: **15 studies, meta-analysis 13 studies** (Most from US and	Longitudinal (23)	Problem gambling (included any measure of problem gambling, pathological gambling or	No CoI declared Co-funded (indirect industry and non-	**Meta-analysis:** 15 longitudinal thematic risk factors for the development of problem gambling were significantly positively associated with subsequent problem gambling (13 individual factors, one relationship factor and one community factor) typically with small to medium	3,4,5

Author, Year (Method of synthesis) Risk of bias rating	Aim / Research question	Study population, Setting, Country, Number and date range of included studies	Study type and number	Outcome(s)	Conflict of interest (CoI) / Funding source declared	Summary of key findings	Risk factor level*
	review of the included studies, examine whether findings are robust to the quality of the study methodologies using sensitivity analyses	Canada) Most papers published from 2000 onwards		gambling disorder)	industry sources)	effect sizes. **Narrative review:** Key findings from papers summarised include for example, one study where impulsivity (measured using a self-report instrument and a card-sorting task) significantly predicted problem gambling after controlling for socio-demographic characteristics, early gambling behaviour, aggressiveness, and anxiety. **Subgroup analysis:** Insufficient data to conduct planned analyses by gender.	

Author, Year (Method of synthesis) Risk of bias rating	Aim / Research question	Study population, Setting, Country, Number and date range of included studies	Study type and number	Outcome(s)	Conflict of interest (CoI) / Funding source declared	Summary of key findings	Risk factor level*
Durdle, 2008 (47) (MA only) AMSTAR 2 rating critically low	To assess the relationship between pathological gambling and Obsessive-Compulsive Disorder	Study population and setting not specified **18 studies:** Countries not specified Published 1991 - 2006	Not specified (18)	Pathological gambling	CoI not reported Co-funded (indirect industry and non industry)	**Meta-analysis:** Authors identified a strong association between pathological gambling and obsessive-compulsive traits, with pathological gamblers showing more traits compared to nonpathological gamblers. A weak association was found between pathological gambling and Obsessive-Compulsive Disorder (effect size = 0.07) and between pathological gambling and Obsessive-Compulsive Personality Disorder (effect size = 0.23). **Subgroup analysis**: None	4
Grall-Bronnec, 2016 (48)	To provide an overview of possibly iatrogenic gambling disorder according to the patients'	Patients using ARI or DRT Setting not specified	Case control (65)	Pathological gambling or problem gambling	CoI declared	**Narrative analysis:** The probability that gambling disorder was due to a dopamine agonist was possible in 16 of 17 ARI	4

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(Narrative only) AMSTAR 2 rating critically low	medication: Aripiprazole (ARI) or Dopamine Replacement Therapy (DRT)	**65 studies.** All France Date range not stated			Direct industry funded	cases and in 46 of 48 DRT cases. **Subgroup analyses:** None	
Guillou 2019 (49) (Narrative only) AMSTAR 2 rating critically low	To provide a broad, cross-cultural picture of the determinants of gambling disorders in older adults	Older gamblers (over 50 years of age) Clinical settings **51 studies:** France (3); Canada (5); Singapore (6); Australia (5); USA (24); Quebec (3); UK (2); New Zealand (1); Finland (1); USA/Brazil (1) Published 2000-2018	Quantitative (35); qualitative (6); mixed methods (2); literature review (6); Case report (1); Communication report (1)	Gambling disorders	CoI declared Direct industry funded	**Narrative review:** Pathological gambling was associated with medical, psychiatric, and social comorbidities among older adults. **Sub-group analysis:** Gender influences gambling habits. Women over 60 are at equivalent (or higher) risk of problem gambling compared to men in the same age group.	2,3,4, 5

Author, Year (Method of synthesis) Risk of bias rating	Aim / Research question	Study population, Setting, Country, Number and date range of included studies	Study type and number	Outcome(s)	Conflict of interest (CoI) / Funding source declared	Summary of key findings	Risk factor level*
Gyollai, 2014 (50) (Narrative only) AMSTAR 2 rating critically low	To provide a systematic review and summary of all the empirical research concerning the genetic background of problem and pathological gambling	Study population and setting not specified **21 studies.** United States (11) Spain (5), Australia (2), Canada (1); non-OECD countries: Brazil (2) Date range not specified	Gene association (21)	Problem gambling; pathological gambling	No CoI declared Not industry funded	**Narrative analysis:** Genetic factors are important in the acquisition, development and maintenance of pathological gambling. Also, it appears that there might be a partial overlapping of the genetic background of gambling problems and comorbid disorders. **Subgroup analysis:** None	3,4,5
Harris, 2018 (51) (Narrative only) AMSTAR 2 rating critically low	1: To evaluate and summarise the existing body of evidence relating to speed of play in gambling 2: To discuss how this evidence can be used to inform harm minimisation approaches aimed at	Study population and setting not specified **11 studies:** Australia (3); Canada (2); Denmark (1); Norway (1); Spain (1); United Kingdom (3) Published 1994 to 2012	Experimental (9) Qualitative (1) observational (1)	Problem gambling behaviour	CoI declared Not industry funded	**Narrative review:** The authors found that all gamblers (non-problem and problem gamblers) showed a consistent preference for games with faster speeds of play and rated them as more exciting. Fast games were particularly appealing to problem gamblers. **Subgroup analysis**: None	1

Author, Year (Method of synthesis) Risk of bias rating	Aim / Research question	Study population, Setting, Country, Number and date range of included studies	Study type and number	Outcome(s)	Conflict of interest (CoI) / Funding source declared	Summary of key findings	Risk factor level*
	facilitating self-control during gambling.						
Ioannidis, 2019 (52) (MA only) AMSTAR 2 rating critically low	To conduct a comprehensive meta-analysis of the range of cognitive domains relevant to impulsivity in gambling disorder.	Study population and setting not specified **50 studies:** United States (6); Europe (29), Asia (7), Other (8) Date range not stated	Not specified (50)	At least some degree of disordered gambling	No CoI declared Not industry funded	**Meta-analysis:** Elevated impulsivity on motor inhibition, attentional inhibition, decision-making tasks and discounting were all associated with gambling disorder. Most results were of medium effect size, apart from Go/No-Go task motor inhibition (small effect size). The authors also reported elevated decision-making impulsivity in problem gamblers compared to controls (medium effect size). **Moderator analysis:** Geographical location moderated cognitive findings, only significant moderating effect of gender was	5

Author, Year (Method of synthesis) Risk of bias rating	Aim / Research question	Study population, Setting, Country, Number and date range of included studies	Study type and number	Outcome(s)	Conflict of interest (CoI) / Funding source declared	Summary of key findings	Risk factor level*
						that studies including male and female participants had larger Stop-signal inhibition deficits than studies including only males. No significant effect of age. **Subgroup analysis:** None	
Kovács, 2017 (53) (MA only) AMSTAR 2 rating critically low	1: To systematically review empirical data concerning decision-making in patients diagnosed with gambling disorder or alcohol disorder compared to healthy control groups 2: To explore whether patients with gambling disorder and alcohol use disorder report similarities in the characteristics of decision-making using	**Clinical population** Setting not specified **17 studies:** Belgium; (1) Canada (1); Denmark (1); France (1); Israel;(1) Italy (3); Netherlands (2) United States (2) Turkey (2); non-OECD countries: Argentina (1); South Korea (2) Date range not specified	Case- control (17)	Pathological gambling or gambling use disorder	No CoI declared Funding unknown	**Meta-analysis:** Gambling disorder was associated with decision-making deficit and this was more pronounced in gambling disorder groups than in alcohol disorder groups. **Moderator analysis:** No significant moderating effects of age, gender or education were found. **Subgroup analysis:** None.	5

Author, Year (Method of synthesis) Risk of bias rating	Aim / Research question	Study population, Setting, Country, Number and date range of included studies	Study type and number	Outcome(s)	Conflict of interest (CoI) / Funding source declared	Summary of key findings	Risk factor level*
	one of the most popular measures of cognitive impulsivity, the Iowa Gambling Task						
Kyonka, 2018 (54) (MA only) AMSTAR 2 rating critically low	1: To test the significance of an overall effect size of the relationship between probability discounting and gambling across studies. 2: To determine whether gambling severity as indicated by a gambling diagnosis moderated the effect size significantly 3: To estimate possible publication bias	Study population and setting not specified **12 studies**. Countries and date range not specified	Case-control (12)	Diagnosed problem gambling	No CoI declared Funding unknown	**Meta-analysis:** A significant association between shallower probability discounting and greater gambling severity or intensity in all 12 studies (Hedges' g = 0.36 [standard error (SE) = 0.07, 95% confidence interval (CI) = 0.21, 0.50), P < 0.001). **Moderator analysis:** Gambling severity (as measured by people with diagnosed gambling disorders compared to non-diagnosed people) was found to moderate the association between probability discounting and	5

Author, Year (Method of synthesis) Risk of bias rating	Aim / Research question	Study population, Setting, Country, Number and date range of included studies	Study type and number	Outcome(s)	Conflict of interest (CoI) / Funding source declared	Summary of key findings	Risk factor level*
						gambling (Q(1) = 7.80, P = 0.005). **Subgroup analysis:** None	
Lane, 2016 (55) (Narrative only) AMSTAR 2 rating critically low	1: To determine whether exposure to child maltreatment increases the risk of problem gambling in adults 2: To determine whether adult problem gamblers are at increased risk of abusing or neglecting their children	Children and young people Setting not specified **23 studies:** countries not specified Date range not stated	Cohort (23)	Problem gambling (to reflect pathologic gambling, compulsive gambling disorder)	CoI not reported Not industry funded	**Narrative review:** Significant positive associations were found between sexual abuse (OR 2.01–3.65) and physical abuse (OR 2.3–2.8) and later gambling problems. Positive associations reported between problem gambling and psychological maltreatment and neglect. When mental health disorders were controlled for, risks were reduced or eliminated in most studies. **Subgroup analysis:** some differences noted by gender	3

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Laplante, 2018 (56) (Narrative only) AMSTAR 2 rating critically low	To provide an evidence-based discussion of the potential impacts of gambling expansion	Study population and setting not specified **20 studies**: Canada (6), Norway (1), Spain (1), Sweden (1), Switzerland (1), UK (2), United States (7); non-OECD: Romania (1), 17 studies published prior to 2013, 3 studies published 2013- January 2018	Prospective; cross-sectional (20 total)	Gambling and gambling-related problem outcomes	CoI not reported Co funded (direct industry, indirect industry and non industry)	**Narrative review:** Gambling expansion was associated with changes in gambling and gambling-related problems. But effects were mixed and there was limited literature available. **Subgroup analysis:** None	2
Levy 2018 (41) (Narrative only)	To provide a comprehensive review of the published research on gambling behaviour in veteran populations	Veterans Clinical and community setting	Longitudinal (6); cross-sectional (46)	Gambling behaviour	No CoI declared	**Narrative review:** Results from reviewed articles included: higher rates of gambling disorder among veterans with comorbid substance use disorders (including alcohol	3,4,5

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AMSTAR 2 rating critically low		**52 studies:** Countries not specified, but 35% of studies utilized data from US based Medical Center Published 1983-2017			Not industry funded	dependence and illicit drug use), lower ego strength, achievement motivation and self-control among gamblers than standardised group norms or control groups. Social presence and intelligence higher for gamblers. An unclear relationship between PTSD and gambling behaviour. Genetic factors and shared family environment were important in people's susceptibility to gambling disorder. **Sub-group analysis:** None	
Loo 2019 (42) (Narrative only)	To analyse and summarise gambling-related findings from the nationally representative US National Epidemiological Survey	Nationally representative sample of adults in US Setting unspecified	Cross-sectional (51)	Problem or pathological gambling	CoI declared Co-funded (indirect	**Narrative review:** Higher odds of pathological gambling was associated with being aged between 45 and 64 years, Black, male, and being separated, divorced or widowed (No	4,5

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AMSTAR 2 rating critically low	on Alcohol and Related Conditions (NESARC) data	**51 studies:** US (51) Published 2005 to 2019			industry and non-industry)	reference categories provided). **Sub-group analysis:** a higher prevalence of pathological gambling reported among Black women and Hispanic men, but no differences found among White men and women.	
MacLaren, 2011 (57) (MA only) AMSTAR 2 rating critically low	1. Hypothesised that problem gambling would be associated with some aspects of impulsivity 2. hypothesised that disagreeable disinhibitory traits would be associated with problem gambling	**Adults** Setting not specified **44 studies:** Countries not specified Date range not stated	Not specified	Problem gambling	CoI not reported Not industry funded	**Meta-analysis:** Problem gambling was associated with unconscientious disinhibition and low premeditation, with negative affect and negative urgency and with disagreeable disinhibition. **Subgroup analysis:** None	5
Marchetti, 2019 (58)	To provide a systematic review of empirical studies of the association	General population Setting not specified	Cross-Sectional (20)	Gambling problems	No CoI declared	**Narrative review:** Alexithymia was significantly associated with gambling. There was a dose-response relationship between	5

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(Narrative only) AMSTAR 2 rating critically low	between alexithymia and gambling	**20 studies**: Australia (1), Belgium (1), Canada (3), France (7), Italy (6), United Kingdom (1), United States (1) Date range not stated			Not industry funded	alexithymia prevalence in people with gambling-related problems; prevalence in pathological gamblers (31 to 52%) and in community samples (34 to 67%). **Subgroup analysis:** None	
Marchica 2019 (59) (Narrative only) AMSTAR 2 rating critically low	To investigate the relationship between emotional regulation and problem gambling and video gaming, and to identify gaps and limitations in the literature.	Individuals presenting with gambling and video gaming problems schools and clinical settings **20 studies:** Taiwan (1), Turkey (1), Australia(1), USA (1), Italy (5), France (2), Spain (4), Singapore (2), China (1),	Longitudinal (2); cross-sectional (18)	Gambling disorder, gambling addiction, pathological gambling	No CoI declared Funding unknown	**Systematic review:** 12 out of 14 studies examining the relationship between emotional regulation and problem gambling found significant results. Four studies (29%) reported large effect sizes, and 3 found that higher emotion dysregulation scores were associated with increased levels of problem gambling (Cohen's d = 0.90–1.02). One study reported a large effect size between maladaptive emotional regulation	5

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		Germany (1), Canada (1) Published 2012-2019				strategies (catastrophizing and self-blame) and problem gambling (Cohen's d = 0.91 and 1.37). **Sub-group analysis:** Studies showed higher prevalence rates for mood disorders and emotional regulation difficulties among females. Authors noted that it was possible that the effect sizes would have been stronger among samples with higher female representation but were unable to test this hypothesis as no study had a sufficiently large sample of females.	
McComb, 2010 (13) (Narrative only)	To identify and understand the possible factors associated with adolescent gambling, across five domains:	**Young people, adults** Setting not specified	Longitudinal (5); cross sectional (16)	Adolescent gambling	CoI not reported	**Narrative review:** Some evidence that family influences are associated with gambling behaviour or problems among adolescents. For example, family	3,4

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AMSTAR 2 rating critically low	1. family sociodemographic factors 2. general family climate 3. parenting practices 4. family members' attitudes and behaviours 5. relationship characteristics	**21 studies:** Australia (1), Canada (12), United Kingdom (1), United States (7) Published 1997-2008			Not industry funded	structural correlates appeared weak but important. Greater family problems were associated with increased risk of problem gambling. Family cohesion was associated with gambling but likely mediated by other risk factors. The predictive role of parenting practices in gambling was unclear and may change over time, favourable parental attitudes to gambling could be associated with gambling. Overall, there appeared most extensive evidence for parental gambling (which was positively linked with greater adolescent gambling). **Subgroup analysis**: None	

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Meng 2014 (60) (MA only) AMSTAR 2 rating critically low	To survey the whole-brain functional neuroimaging investigations of gambling disorder using the effect size-signed differential mapping (ES-SDM) approach for quantitative meta-analysis to synthesize the findings from fMRI studies of gambling disorder. Secondarily, to characterise the states and traits related to this activation by systematically reviewing correlations between activation and behaviours	Study population not stated Setting not specified **13 studies:** The Netherlands (4); U.S (4); Canada (2); Germany (2); Korea (1) Published 2003-2012	Neuroimaging (13)	Gambling disorder	No CoI declared Not industry funded	**Meta-analysis:** People with gambling disorder had significant hyperactivity in the lentiform nucleus compared with healthy controls. This finding was consistent with most others from previous MRI studies in gambling disorder**.** **Sub-group analysis:** None	7

Author, Year (Method of synthesis) Risk of bias rating	Aim / Research question	Study population, Setting, Country, Number and date range of included studies	Study type and number	Outcome(s)	Conflict of interest (CoI) / Funding source declared	Summary of key findings	Risk factor level*
Merkouris, 2016 (61) (Narrative only) AMSTAR 2 rating critically low	To review the most recent evidence relating to gender differences in the characteristics associated with problem gambling (including pathological, disordered, and at-risk gambling)	**Adults and adolescents.** Community (hospital); High school; Psychiatric outpatients; Community College **29 studies:** Australia (4); Canada (4); Finland (2); France (1); Italy (1); New Zealand (1); Spain (4): Sweden (3); United States (8); non-OECD countries: Hong Kong (1) Published 2012 - 2015	Surveys; others not specified (total 29)	Problem gambling (including pathological, disordered, and at-risk gambling)	CoI declared Funding unknown	**Narrative review:** Female gamblers were more likely than males to have experienced childhood abuse, unemployment and greater psychological distress. Male problem gamblers had higher rates of substance use (specific substance unreported) and alcohol use and greater impulsivity. The findings were mostly equivocal, which suggested that the profile of male and female problem gamblers was more similar than different. Authors noted the findings were consistent with the gender-as-proxy hypothesis with gender playing an indirect rather than direct role in the development of problem gambling along with	3,4,5

Author, Year (Method of synthesis) Risk of bias rating	Aim / Research question	Study population, Setting, Country, Number and date range of included studies	Study type and number	Outcome(s)	Conflict of interest (CoI) / Funding source declared	Summary of key findings	Risk factor level*
						other demographic, and health-related and economic characteristics. **Subgroup analysis:** Significant differences by gender and ethnicity. Mixed results for socioeconomic status and gender. Some evidence for gender differences by family characteristics.	
Moccia 2017 (62) (MA only) AMSTAR 2 rating critically low	To systematically review functional magnetic resonance imaging (fMRI) studies that target cognitive control and impulsivity in gambling disorder	Adults with pathological gambling or problem gambling Setting not specified **14 studies:** Belgium (1); USA (3); Netherlands (3); Denmark (1); UK (1); Germany (3); Canada	Neuroimaging (14)	Pathological gambling or problem gambling	CoI not reported Funding unknown	**Meta-analysis:** Impaired activity in prefrontal areas may account for impaired cognitive control, which contributes to aspects of problem gambling such as those related to progressive loss of control over gambling behaviours. Orbital and ventromedial areas appear to be a possible nexus for value based decision-making,	6

Author, Year (Method of synthesis) Risk of bias rating	Aim / Research question	Study population, Setting, Country, Number and date range of included studies	Study type and number	Outcome(s)	Conflict of interest (CoI) / Funding source declared	Summary of key findings	Risk factor level*
		(1); Spain (1) Published 2007 to 2016				emotional processing and sensory integration. As such they may contribute to motivational and affective aspects of cognitive control. **Sub-group analysis:** None	
Molde, 2018 (63) (MA only) AMSTAR 2 rating critically low	To determine the overall prevalence rate of Impulse-Control Disorders in Parkinson's Disease and factors that might moderate this relationship	**Parkinson's disease patients** Setting not specified **14 studies:** Czech Republic (1), France (2), Israel (1), Italy (3), Mexico (1), Norway (1), Spain (1), US (2); non-OECD countries (n): India (1), Brazil (1) Date range not stated	Case control (14)	Impulse-Control Disorders and/or Impulse-Control Disorders and related behaviours	No CoI declared Funding unknown	**Meta-analysis:** People with Parkinson's disease had 2.7 times higher odds of gambling compared to healthy controls (OR = 2.70, CI 95% CI = 1.56, 4.67). **Subgroup analysis:** None	4

Author, Year (Method of synthesis) Risk of bias rating	Aim / Research question	Study population, Setting, Country, Number and date range of included studies	Study type and number	Outcome(s)	Conflict of interest (CoI) / Funding source declared	Summary of key findings	Risk factor level*
Nowak, 2018 (64) (MA only) AMSTAR 2 rating critically low	1. To determine the overall proportions of problem and pathological gambling among college students over the last 30 years 2: How do factors such as gender, age, race, national origin, and year in which a study was conducted influence the rates of problem and pathological gambling among college students?	Students College and Universities **70 studies:** Australia (2), Canada (5), Japan (1), New Zealand (3), Spain (1), United Kingdom (2), United States (50); non-OECD countries: Singapore (1), Lebanon (2), Argentina (1), Nigeria (1), China (1) Published 1990-2014	Not specified (70)	Problem and pathological gambling	No CoI declared Funding unknown	**Meta-analysis:** College students' prevalence of both problem and pathological gambling was higher than those estimated for the general population. **Moderator analysis:** Statistically significant relationship between pathological gambling and male students (but not in the analyses of college students and problem gambling rates). Statistically significant increase in pathological gambling rates for non-white students. No differences in pathological and problem gambling rates among college students as mean age of students increased. No statistical significance between pathological or problem gambling rates in	4,5

Author, Year (Method of synthesis) Risk of bias rating	Aim / Research question	Study population, Setting, Country, Number and date range of included studies	Study type and number	Outcome(s)	Conflict of interest (CoI) / Funding source declared	Summary of key findings	Risk factor level*
						students from North America (United States and Canada) compared to international students. **Subgroup analysis:** None	
Peters, 2015 (65) (Narrative only) AMSTAR 2 rating critically low	To provide an updated review of the literature on gambling and its associations with tobacco, alcohol, and illicit drug use among youth in the US.	Young people US **10 studies:** US (10) Published 2000 - 2014	Surveys (10)	Adolescent gambling	No CoI declared Not industry funded	**Narrative review:** Significant associations found between gambling and tobacco use, alcohol use, and illicit drug use.	4

Author, Year (Method of synthesis) Risk of bias rating	Aim / Research question	Study population, Setting, Country, Number and date range of included studies	Study type and number	Outcome(s)	Conflict of interest (CoI) / Funding source declared	Summary of key findings	Risk factor level*
Quaglieri 2020 (66) (MA only) AMSTAR 2 rating critically low	1: To summarise previous findings about the neural correlates of gambling and in terms of the activation and deactivation of the brain areas devoted to executive control. 2: Provide new evidence for common and distinct neural mechanisms in this condition.	Adults with gambling disorder without comorbidity or dependence on other substances Setting not specified **21 studies:** countries not specified Published 2003 to 2018	Experimental (21)	Gambling disorder	No CoI declared Not industry funded	**Meta-analysis:** Gambling disorder was associated with higher activation of the fronto-striatal circuit and with activation of the reward network. There was also greater activity in the bilateral dorsal striatum in people with gambling disorder, which is linked to stronger action–outcome associations. This activity could relate to people overestimating gambling outcomes. **Sub-group analysis:** None	6
Scholes-Balog, 2012 (67) (Narrative only)	1: To systematically summarise and evaluate the available literature examining the associations between online gambling and both mental health and	General population: online gamblers (of any age) Setting not specified **12 papers.** No studies not specified	Cross-sectional (12)	Online gambling	No CoI declared Funding unknown	**Narrative review:** Limited research and sometimes inconsistent findings about the relationships between problem online gambling and specific mental health and substance use problems, for example, alcohol,	4

Author, Year (Method of synthesis) Risk of bias rating	Aim / Research question	Study population, Setting, Country, Number and date range of included studies	Study type and number	Outcome(s)	Conflict of interest (CoI) / Funding source declared	Summary of key findings	Risk factor level*
AMSTAR 2 rating critically low	substance use. 2: To highlight studies that compared online gambling to venue-based gambling to address the question of whether online gambling is associated with the same mental health and substance use problems that are linked with more traditional venue-based gambling.	Countries and date range not specified				nicotine marijuana, inhalants, solvents and other illicit substances. Authors conclude further investigation needed. **Subgroup analysis:** None	
Smith, 2014 (68) (MA only) AMSTAR 2 rating	To determine whether inhibitory ability is reliably impaired in substance users compared to controls.	General population Setting not specified **8 studies:** Countries not specified Published 2005-2012	Experimental (8)	Gambling and pathological gambling	No CoI declared Not industry funded	**Meta-analysis:** Inhibitory deficits were apparent in pathological gamblers. For example, there were medium-large deficits in the Stop Signal Task for gambling. However, authors found no evidence of performance deficits in the equiprobable Go/NoGo task	5

Author, Year (Method of synthesis) Risk of bias rating	Aim / Research question	Study population, Setting, Country, Number and date range of included studies	Study type and number	Outcome(s)	Conflict of interest (CoI) / Funding source declared	Summary of key findings	Risk factor level*
critically low						or the frequent-Go/rare-NoGo task. This suggests that there is no association between pathological gambling and a deficit in withholding, but instead an association with a deficit in stopping an inappropriate response. **Subgroup analysis:** None	
Spurrier, 2014 (69) (Narrative only) AMSTAR 2 rating critically low	1: To evaluate existing evidence related to: gamblers' perceptions of gambling risks and harms; and the relationship between risk perception and behaviour. 2: To determine what research tells us about the harmful outcomes gamblers expect from	Study population and setting not specified **16 studies:** Countries and date range not specified	Cross-sectional (16)	Negative or harmful consequences of gambling; perception of risk or likelihood of potentially harmful	CoI not reported Funding unknown	**Narrative review:** There is a scarcity of research that investigates gamblers' perceptions of the potential harms and risk associated with gambling. Risk perception appears to vary according to contextual factors or individual differences, for example gamblers' exposure to gaming and cultural experiences. **Moderator analysis:** The role of	5

Author, Year (Method of synthesis) Risk of bias rating	Aim / Research question	Study population, Setting, Country, Number and date range of included studies	Study type and number	Outcome(s)	Conflict of interest (CoI) / Funding source declared	Summary of key findings	Risk factor level*
	gambling, the role of gambling outcome expectations in decision-making and behaviour, and cognitive factors that moderate relationships between outcome perception and choice behaviour.			consequences of gambling		risk perception in decision-making and behaviour may be moderated by a range of factors including awareness of consequences, perceived qualities of anticipated outcomes, and responses to conflicting cognitions. **Subgroup analysis:** None	
Subramaniam, 2015 (70) (Narrative only) AMSTAR 2 rating critically low	1: To systematically review studies on the prevalence of gambling disorder among older adults aged 60 years and above. 2: To summarise the evidence on the determinants, risk factors as well as the	Adults aged 60 years and above Setting not specified **24 studies:** Australia (2); Canada (2); Denmark (1); Sweden (2); United States (16); US and Sweden (1) Date range not stated	Not specified (24)	Pathological or problem gambling	Not industry funded No COI declared	**Narrative review:** Younger age groups of 'older' people aged 60 and above have a higher risk of gambling. Prevalence of problem and pathological gambling is often higher among older females, however some studies found risk was similar among older females and males. Some studies reported those with gambling disorder more likely to be single, divorced	2,3,4,5

Author, Year (Method of synthesis) Risk of bias rating	Aim / Research question	Study population, Setting, Country, Number and date range of included studies	Study type and number	Outcome(s)	Conflict of interest (CoI) / Funding source declared	Summary of key findings	Risk factor level*
	comorbidities associated with it.					or separated. Race and ethnicity were also identified as risk factors for pathological gambling. Education and income were identified by some studies as risk factors for problem and pathological gambling while others failed to find any association. Lack of senior optimism, lower social support networks, availability of household transportation and increased casino visitation were significantly associated with a higher risk of problem gambling behaviour. Heavy or pathological gamblers reported a greater number of stressful life-events compared to non-gamblers or occasional gamblers.	

Author, Year (Method of synthesis) Risk of bias rating	Aim / Research question	Study population, Setting, Country, Number and date range of included studies	Study type and number	Outcome(s)	Conflict of interest (CoI) / Funding source declared	Summary of key findings	Risk factor level*
						Subgroup analysis: See narrative review	
Theule, 2016 (71) (MA only) AMSTAR 2 rating critically low	To clarify the association between problem gambling and Attention Deficit Hyperactivity Disorder (ADHD) and address how the following moderators affect the association between ADHD symptoms and gambling severity: sample gender make-up, mean age of sample, country of publication, date of publication, and publication type	Study population and setting not specified **24 studies.** Australia (2), Canada (7), New Zealand (1), United States (9), Unspecified (5) Published 1992-2014	Quantitative (24)	Gambling, pathological gambling, or gambling severity	No CoI declared Indirectly industry funded	**Meta-analysis:** Statistically significant correlation between symptoms of ADHD and gambling severity (moderate association). **Moderator analysis:** Results of moderator analysis for gender was not statistically significant. There was a trend for the association between symptoms of ADHD and gambling severity to be stronger for middle age adults, than for younger sample. **Subgroup analysis:** See moderator analysis	5

Author, Year (Method of synthesis) Risk of bias rating	Aim / Research question	Study population, Setting, Country, Number and date range of included studies	Study type and number	Outcome(s)	Conflict of interest (CoI) / Funding source declared	Summary of key findings	Risk factor level*
Van Holst 2010 (72) (Narrative only) AMSTAR 2 rating critically low	To provide an updated overview of research findings and challenges regarding the neuropathology of pathological gambling	Gamblers Clinical setting **26 studies:** Countries not specified Published 2003 - 2008	Clinical studies (26)	Pathological gambling or problem gambling	CoI not reported Funding unknown	**Systematic review:** Pathological gamblers exhibited neurobiological abnormalities that are also present in other addictions. Abnormal reward and punishment sensitivity, diminished inhibition, and disadvantageous decision making were most consistently reported. Cue reactivity and attentional bias were also reported but less consistently. **Sub-group analysis:** None	6
van Timmeren, 2018 (73) (Narrative and MA)	1: To determine if there is evidence for compulsive behaviour in individuals suffering from gambling disorder, as compared to healthy controls. 2: To perform meta-	Adults (aged 18 to 65 years) Setting not specified **29 studies:** Countries not specified	Experimental (29)	Gambling disorder patients; pathological gamblers or gamblers with a South	No CoI declared Co-funded (indirect industry	**Meta-analysis**: Compared to healthy controls, people with gambling disorder generally exhibited performance deficits in cognitive flexibility, attentional bias and set-shifting. These findings support the view that	5

Author, Year (Method of synthesis) Risk of bias rating	Aim / Research question	Study population, Setting, Country, Number and date range of included studies	Study type and number	Outcome(s)	Conflict of interest (CoI) / Funding source declared	Summary of key findings	Risk factor level*
AMSTAR 2 rating critically low	analyses for all separate tasks within each domain to summarise the available knowledge.	Published 1993 - 2017		Oaks Gambling Screen score of more than 5	and non-industry)	gambling disorder is characterised by neurocognitive impairments related to compulsivity, as exemplified in perseveration (repetition of a particular response) and cognitive inflexibility. **Narrative review:** Authors present a qualitative summary of the findings across each task **Subgroup analysis:** None	
Vasiliadis, 2013 (74) (Narrative only) AMSTAR 2 rating	To review the literature addressing the relationship between electronic gaming machines and venue proximity, venue density, rates of gambling participation, expenditure, problem gambling, and	Study population and setting not specified **39 studies**. Australia (17), Canada (10), New Zealand (5), Norway (1), United States (6) Published 1998-2010	Cross-sectional; studies which reported original, empirical findings (39)	Problem gambling	No CoI declared Funding known	**Narrative review:** There appears to be a relationship between increased gambling involvement and venue or machine proximity and density. The association between proximity and increased problem gambling rates is more strongly associated than density. Findings were complicated by the	2

Author, Year (Method of synthesis) Risk of bias rating	Aim / Research question	Study population, Setting, Country, Number and date range of included studies	Study type and number	Outcome(s)	Conflict of interest (CoI) / Funding source declared	Summary of key findings	Risk factor level*
critically low	gambling-related help-seeking.					diversity of gaming markets and theoretical and methodological limitations. **Subgroup analysis:** Some studies accounted for SES status	
Wardle, 2019a (75) (Narrative only) AMSTAR 2 rating critically low	To provide the first synthesis of key themes and concepts identified from qualitative investigations of youth gambling behaviour in order to map what research has been done and identify gaps.	Children, young people Setting not specified **15 studies:** Australia (8), Belgium (1), Canada (5), Portugal (1) Published 1993 - 2017	Qualitative (15)	Gambling perceptions and behaviours	CoI declared Not industry funded	**Narrative review:** Important concepts identified in the review (in terms of shaping the normative environment in which young people's perceptions are formed but also as direct influencers and facilitators of gambling behaviour) include the role of families, peers, advertising and technology. **Subgroup analyses**: None	2,5
Wardle, 2019b (76) (Narrative only)	To examine literature on the extent to which migrants participate in gambling and the reasons	**Adults (migrants)** Setting not specified **38 studies:** Australia (16); New Zealand	Quantitative (12), qualitative (5); mixed-methods (11)	Gambling participation	CoI declared	**Narrative review:** Migrants appeared less likely to gamble than non-migrants, however they were more likely to experience problems or be at risk of	1,2,4

Author, Year (Method of synthesis) Risk of bias rating	Aim / Research question	Study population, Setting, Country, Number and date range of included studies	Study type and number	Outcome(s)	Conflict of interest (CoI) / Funding source declared	Summary of key findings	Risk factor level*
AMSTAR 2 rating critically low	and motivations for gambling participation.	(9); Denmark (1); United Kingdom (3); United States (3); Finland (3); Germany (1); Spain (1); Worldwide focus (1) Date range not specified	review papers (6); annual reports (2); discussion paper (1); strategic plan (1)		Not industry funded	developing problems from their gambling. Acculturation difficulties that may contribute to gambling having a negative effect could include lack of language proficiency, difficulty fitting into a new society, lack of leisure activities, being under pressure to send money back to family, social isolation, negative or traumatic life events, immigration-related problems, and advertising or promotions from gambling operators. **Subgroup analysis:** None	

Notes:
* Risk factor level: 1 Societal; 2 Community; 3 Family and social; 4 Individual (proximal); 5 Individual (distal); 6 Neurological

3.4 Quality assessment of reviews

All but one review (n = 38) were rated as being of 'critically low quality' based on AMSTAR 2 assessments due to significant methodological or reporting weaknesses. Only one review, a MA of longitudinal studies examining problem gambling risk factors among children and young people, (15) was rated as 'high quality'. Few (n = 6) reviews reported having a protocol and only some of these had registered their protocol before starting their review. Most of reviews (n = 35) had not assessed the risk of bias of their included studies. Most reviews (n = 35) had conducted satisfactory searches of the available literature. This means that they had searched at least 2 relevant databases and provided key words or a search strategy.

Of the 39 reviews, 8 reviews did not include any conflict of interest statement (13, 47, 55-57, 62, 69, 72). Of the 31 that did include a declaration of interest statement, 7 declared potential conflicts (42, 48, 49, 51, 61, 75, 76). The funding for 13 of the 39 reviews was not reported on and is unknown. Of the 27 reviews that did report on the funding for the research:

- 19 reviews were not industry funded
- 5 were co-funded by a mix of industry and non-industry stakeholders (15, 42, 47, 56, 73)
- 2 were directly funding by gambling industry stakeholders (48, 49)

Taken together, this resulted in 14 reviews being marked down on AMSTAR 2 in this domain, and it seems likely that this body of evidence has at least some biases relating to either CoI or funding sources.

Table 2 shows an overview of AMSTAR 2 scoring. You can find further details on the AMSTAR 2 rating used to describe the overall confidence in the results of the reviews in Appendix F.

3.5 Terminology

A range of terminology was used in the included reviews to describe the relationship between a potential risk factor and gambling. Some of the studies used terms such as 'predictor' or 'risk factor' but were often unclear about how this was measured. We decided to use the same terminology that the review authors used, except to only use 'association' when there is an estimated statistical association reported. Otherwise, we used the terms 'link' or 'relationship' but note that no further information was provided.

As expected, there were a variety of terms used to describe gambling at harmful levels, including 'problem gambling', 'pathological gambling' and 'gambling disorder'.

Although these tended to focus on people who meet certain criteria to be diagnosed as having a gambling problem, various measurement tools were used, and the criteria differed between reviews. Due to these limitations, we included all studies reporting on any factors associated with any type of gambling activity to ensure we captured all harmful gambling.

Table 2 (a): AMSTAR 2 ratings for meta-analyses

18 Meta-analyses	1 PICO	2 Protocol	3 Study designs	4 Literature Search	5 Study Selection	6 Data extraction	7 Excluded studies	8 Included studies	9 RoB (satisfactory technique)	10 Funding sources
		CRITICAL		CRITICAL					CRITICAL	
Amlung (2017)	Yes	No	No	Partial yes	No	No	No	Partial yes	No	No
Bouguettaya (2020)	Yes	No	Yes	Yes	No	No	No	Yes	No	No
Callan (2015)	Yes	No	Yes	No	No	No	No	Partial yes	No	No
Chowdhury (2017)	Yes	No	Yes	Partial yes	No	No	No	Partial yes	No	No
Dowling (2016)	Yes	No	Yes	Partial yes	Yes	Yes	No	Yes	No	No
Dowling (2017)	Yes	Yes	Yes	Partial yes	No	Yes	No	Yes	Yes	Yes
Durdle (2008)	Yes	No	No	Partial yes	No	Yes	No	Partial yes	No	No
Ioannidis (2019)	Yes	Yes	Yes	No	No	No	No	Yes	Yes	No
Kovacs (2017)	Yes	No	No	Partial yes	No	No	No	Yes	No	No

18 Meta-analyses	1 PICO	2 Protocol	3 Study designs	4 Literature Search	5 Study Selection	6 Data extraction	7 Excluded studies	8 Included studies	9 RoB (satisfactory technique)	10 Funding sources
		CRITICAL		CRITICAL					CRITICAL	
Kyonka (2018)	Yes	No	Yes	Yes	No	Yes	No	Partial yes	No	No
MacLaren (2011)	Yes	No	Yes	Partial yes	No	No	No	Yes	No	No
Meng (2014)	Yes	No	Yes	Partial yes	No	No	Yes	Partial yes	Yes	No
Molde (2018)	Yes	No	Yes	Partial yes	No	Yes	Yes	Partial yes	No	No
Nowak (2018)	Yes	No	Yes	Partial yes	No	Yes	Partial yes	Partial yes	No	Yes
Quaglieri (2020)	Yes	No	Yes	Partial yes	No	Yes	No	Partial yes	No	No
Smith (2014)	Yes	No	Yes	Partial yes	Yes	No	No	Yes	No	No
Theule (2016)	Yes	No	Yes	Partial yes	No	Yes	No	Partial yes	No	No
van Timmeren (2018)	Yes	Yes	Yes	Partial yes	Yes	No	No	Partial yes	Yes	No

Table 3(b): AMSTAR 2 ratings for meta-analyses (continued)

18 Meta-analyses	11 MA (used appropriate methods)	12 MA (impact of RoB)	13 RoB (interpreting /discussing results)	14 Heterogeneity	15 Publication Bias	16 Conflict	Current overall rating (7 possible critical flaws)	Total flaws	Critical flaws (for example, score no in a critical domain)	Non-critical flaws (for example, score partial yes in a critical domain)
	CRITICAL		CRITICAL		CRITICAL	CRITICAL				
Amlung (2017)	Yes	No	No	No	Yes	Yes	CL	12	3	1
Bouguettaya (2020)	Yes	No	No	No	Yes	Yes	CL	9	3	0
Callan (2015)	Yes	No	No	No	Yes	Yes	CL	11	4	0
Chowdhury (2017)	Yes	No	No	Yes	No	Yes	CL	11	4	1
Dowling (2016)	Yes	No	No	No	No	Yes	CL	9	4	1
Dowling (2017)	Yes	Yes	Yes	No	Yes	Yes	High	4	0	1
Durdle (2008)	No	No	No	No	Yes	No	CL	13	5	1

18 Meta-analyses	11 MA (used appropriate methods)	12 MA (impact of RoB)	13 RoB (interpreting /discussing results)	14 Heterogeneity	15 Publication Bias	16 Conflict	Current overall rating (7 possible critical flaws)	Total flaws	Critical flaws (for example, score no in a critical domain)	Non-critical flaws (for example, score partial yes in a critical domain)
	CRITICAL		CRITICAL		CRITICAL	CRITICAL				
Ioannidis (2019)	No	Yes	Yes	No	Yes	No	CL	8	3	0
Kovacs (2017)	Yes	No	No	Yes	Yes	Yes	CL	10	3	1
Kyonka (2018)	Yes	Yes	No	Yes	Yes	Yes	CL	7	3	0
MacLaren (2011)	Yes	No	No	No	Yes	No	CL	11	4	1
Meng (2014)	Yes	No	No	Yes	Yes	Yes	CL	8	2	1
Molde (2018)	Yes	No	No	Yes	Yes	Yes	CL	8	3	1
Nowak (2018)	Yes	No	No	No	Yes	Yes	CL	9	3	1
Quaglieri (2020)	Yes	No	No	No	No	Yes	CL	11	4	1

18 Meta-analyses	11 MA (used appropriate methods)	12 MA (impact of RoB)	13 RoB (interpreting /discussing results)	14 Heterogeneity	15 Publication Bias	16 Conflict	Current overall rating (7 possible critical flaws)	Total flaws	Critical flaws (for example, score no in a critical domain)	Non-critical flaws (for example, score partial yes in a critical domain)
	CRITICAL		**CRITICAL**		**CRITICAL**	**CRITICAL**				
Smith (2014)	Yes	No	No	Yes	No	Yes	CL	9	4	1
Theule (2016)	Yes	No	No	No	No	Yes	CL	11	4	1
van Timmeren (2018)	Yes	No	No	Yes	No	Yes	CL	8	2	1

Table 4 (a): AMSTAR 2 ratings for systematic reviews

21 Systematic reviews	1 PICO	2 Protocol	3 Study designs	4 Literature Search	5 Study Selection	6 Data extraction	7 Excluded studies	8 Included studies	9 RoB (satisfactory technique)	10 Funding sources
		CRITICAL		CRITICAL					CRITICAL	
Grall-Bronnec (2016)	Yes	No	No	Partial yes	Yes	No	No	No	No	No
Guillou (2019)	Yes	No	Yes	Partial yes	Yes	No	No	Partial yes	No	No
Gyollai (2014)	Yes	No	No	Partial yes	No	No	No	Partial yes	No	No
Harris (2018)	Yes	No	Yes	Partial yes	No	No	No	Yes	No	No
Lane (2016)	Yes	No	Yes	Partial yes	No	No	No	Partial yes	Partial yes	No
Laplante (2018)	Yes	No	Yes	No	No	Yes	No	Partial yes	Partial yes	No
Levy (2018)	Yes	No	Yes	Partial yes	No	No	No	Yes	No	No
Loo (2019)	Yes	Yes	Yes	Partial yes	Yes	Yes	No	Yes	No	No
Marchetti (2019)	Yes	No	Yes	Partial yes	No	Yes	No		No	No

21 Systematic reviews	1 PICO	2 Protocol	3 Study designs	4 Literature Search	5 Study Selection	6 Data extraction	7 Excluded studies	8 Included studies	9 RoB (satisfactory technique)	10 Funding sources
Marchica (2019)	Yes	No	Yes	Partial yes	No	No	No	Yes	No	No
McComb (2010)	Yes	No	No	Partial yes	No	No	No	Partial yes	No	No
Merkouris (2016)	Yes	No	No	No	No	No	No	Yes	No	No
Moccia (2017)	Yes	No	Yes	Partial yes	Yes	Yes	Yes	Yes	No	No
Peters (2015)	Yes	No	Yes	Partial yes	No	No	No	Yes	No	No
Scholes-Balog (2012)	Yes	No	No	Partial yes	No	No	No	Partial yes	No	No
Spurrier (2014)	Yes	No	No	Partial yes	No	No	No	Yes	No	No
Subramaniam (2015)	Yes	No	No	Partial yes	Yes	No	No	Yes	No	No
van Holst (2010)	Yes	No	Yes	Partial yes	No	No	No	Partial yes	No	No
Vasiliadis (2013)	Yes	No	No	Partial yes	No	Yes	No	Yes	No	No
Wardle	Yes	Yes	Yes	Partial yes	No	No	No	Yes	Partial yes	No

21 Systematic reviews	1 PICO	2 Protocol	3 Study designs	4 Literature Search	5 Study Selection	6 Data extraction	7 Excluded studies	8 Included studies	9 RoB (satisfactory technique)	10 Funding sources
(2019)										
Wardle (2019)b	Yes	Yes	No	Partial yes	Yes	Yes	No	Yes	Partial yes	No

Table 4 (b): AMSTAR 2 ratings for systematic reviews (continued)

21 Systematic reviews	11 MA (used appropriate methods)	12 MA (impact of RoB)	13 RoB (interpreting /discussing results)	14 Heterogeneity	15 Publication Bias	16 Conflict	Current overall rating (7 possible critical flaws)	Total flaws	Critical flaws (for example, score no in a critical domain)	Non-critical flaws (for example, score partial yes in a critical domain)
	CRITICAL		**CRITICAL**		**CRITICAL**	**CRITICAL**				
Grall-Bronnec (2016)	Not applicable	Not applicable	No	No	Not applicable	Yes	CL	10	3	1
Guillou (2019)	Not applicable	Not applicable	Yes	No	Not applicable	Yes	CL	8	2	1
Gyollai (2014)	Not applicable	Not applicable	No	No	Not applicable	Yes	CL	11	3	1
Harris (2018)	Not applicable	Not applicable	Yes	No	Not applicable	No	CL	9	3	1
Lane (2016)	Not applicable	Not applicable	No	No	Not applicable	No	CL	11	3	2
Laplante (2018)	Not applicable	Not applicable	Yes	No	Not applicable	No	CL	9	3	1
Levy (2018)	Not applicable	Not applicable	No	No	Not applicable	Yes	CL	9	3	1

21 Systematic reviews	11 MA (used appropriate methods)	12 MA (impact of RoB)	13 RoB (interpreting /discussing results)	14 Heterogeneity	15 Publication Bias	16 Conflict	Current overall rating (7 possible critical flaws)	Total flaws	Critical flaws (for example, score no in a critical domain)	Non-critical flaws (for example, score partial yes in a critical domain)
Loo (2019)	Not applicable	Not applicable	No	No	Not applicable	No	No	7	3	1
Marchetti (2019)	Not applicable	Not applicable	No	No	Not applicable	Yes	CL	9	3	1
Marchica (2019)	Not applicable	Not applicable	No	No	Not applicable	Yes	CL	9	3	1
McComb (2010)	Not applicable	Not applicable	No	No	Not applicable	No	CL	12	4	1
Merkouris (2016)	Not applicable	Not applicable	No	No	Not applicable	No	CL	11	5	0
Moccia (2017)	Not applicable	Not applicable	No	Yes	Not applicable	No	CL	6	4	1
Peters (2015)	Not applicable	Not applicable	No	No	Not applicable	Yes	CL	9	3	1
Scholes-Balog (2012)	Not applicable	Not applicable	No	No	Not applicable	Yes	CL	11	3	1
Spurrier (2014)	Not applicable	Not applicable	No	Yes	Not applicable	No	No	10	4	1

21 Systematic reviews	11 MA (used appropriate methods)	12 MA (impact of RoB)	13 RoB (interpreting /discussing results)	14 Heterogeneity	15 Publication Bias	16 Conflict	Current overall rating (7 possible critical flaws)	Total flaws	Critical flaws (for example, score no in a critical domain)	Non-critical flaws (for example, score partial yes in a critical domain)
Subramaniam (2015)	Not applicable	Not applicable	No	No	Not applicable	Yes	CL	9	3	1
van Holst (2010)	Not applicable	Not applicable	No	No	Not applicable	No	No	11	4	1
Vasiliadis (2013)	Not applicable	Not applicable	No	Yes	Not applicable	Yes	CL	8	3	1
Wardle (2019)	Not applicable	Not applicable	No	No	Not applicable	No	CL	9	2	2
Wardle (2019)b	Not applicable	Not applicable	No	No	Not applicable	No	CL	8	2	2

3.6 Potential risk factors

As outlined earlier, we used an adapted version of the socio-ecological model that draws upon the social determinants of health model (24) to structure the synthesis of the results. The model considers factors at 4 different levels. These were:

- individual
- family or social
- community
- societal

Some risk factors may have fitted in more than one level, but for reporting purposes we chose the most relevant category. Some of the potential risk factors were based on small numbers of studies with limited detail provided on their type or quality. If the authors did not report the number of studies that informed their findings, we estimated the total as ‘one or more’ to give an approximate total.

Given the deliberately wide scope of our search, evidence of neurological characteristics that may influence gambling was also identified. This is outside the scope of our conceptual model. We have included a summary of these findings in the results section of this report. But we have not explored them further in the discussion and not counted these towards our total count of risk factors identified.

Some reviews contained evidence of potential risk factors across the 4 levels described above (10 reviews), whereas others focused on one level (25 reviews). Most reviews considered individual factors (29 reviews), with far less evidence available for family or social (10 reviews) community (7 reviews) or societal factors (6 reviews). There was no clear pattern in review publication dates by levels except for those focused on societal factors, which were published more recently than those that focused on individual level factors.

A total of 44 potential risk factors were identified across the reviews. Most were categorised as individual level (n=32), compared to family or social level factors (n=5), community level factors (n=4) and societal level factors (n=3). Twenty-five of the possible risk factors had been examined in relation to harmful gambling and 4 of the possible risk factors had been examine in relation to gambling. Fifteen possible risk factors had been examined in relation to both gambling and harmful gambling. To accommodate the large number of potential risk factors in some levels, we summarised similar or related factors together.

The tables below (Tables 5 to 10) show the number of reviews and primary studies that highlighted potential risk factors. This is based on the number of studies, and the numbers do not relate to any relationship or the extent of gambling.

Societal influences

Societal influences are the policy, legal and regulatory climates, and the socio-economic, cultural and environmental conditions that can influence gambling behaviour.

Five reviews, one of which included an MA, included 44 studies of possible societal risk factors for gambling. The risk factors were advertising and marketing, speed of play of gambling products and types of gambling (Table 5).

Table 5: Societal influences: potential risk factors and number of studies

Risk factor	Reference [number of studies]	Total reviews	Total studies
Advertising and marketing	Wardle 2019a (75) [8]; Merkouris 2016 (61) [1]; Bouguettaya 2020 (43) [23]	3	32
Speed of play	Harris 2019 (51) [11]	1	11
Types of gambling	Guillou 2019 (49) [1]	1	1

Advertising and marketing

Three reviews, one of which included an MA, reported on 32 studies discussing advertising and marketing.

The review with an MA included 23 studies (14 cross-sectional, one experimental, 3 quasi-experimental and 5 qualitative), that looked at the associations between advertising and marketing and gambling. Sixteen looked at gambling and 5 looked at problem gambling but these were reported on together under the umbrella of 'gambling behaviour'. Fifteen studies reported enough data to be included in the MA and a positive association was found between exposure to gambling advertising and gambling (r = 0.24; 95% CI = 0.13, 0.36). Fourteen of the 15 studies that had conducted statistical analysis reported a significant relationship. Some included studies observed a 'dose-response' relationship, where increased exposure to advertising led to increased gambling (43). Similarly, a review of qualitative studies reported that young gamblers were encouraged to gamble as a result of bonus offers they saw advertised and marketed towards them, sometimes through personalised ads (75).

One review focused on the role of gender differences in the characteristics associated with harmful gambling (61). It reported that one study found both male and female

gamblers were influenced by advertising to start a gambling episode, however no data on the association between these factors was reported.

In summary, the body of evidence appears to show that advertising and marketing influences gambling in adults and, to a lesser extent, children and young people. More high-quality review-level evidence and longitudinal data is needed to increase the level of confidence in this finding for all age groups. There is a lack of review-level evidence examining if marketing and advertising is a risk factor for harmful gambling for any age group.

Speed of play

The gambling industry manipulates the speed of play of gambling games, so we considered this a possible societal risk factor. One review of 11 studies investigating the impact of speed of play on gambling and harmful gambling reported mixed results (51). Five studies reported that faster games led all gamblers to place more bets. One study reported problem gamblers placing bigger bets on fast games. Several studies (number not reported) found that problem gamblers found it difficult to stop faster play. But the authors also reported that several other studies (number not reported) reported no association between speed of play and gambling outcomes.

The mixed findings of this one review, and the lack of high quality review-level or longitudinal evidence available, makes it difficult to reach any conclusions about whether speed is a risk factor for gambling or harmful gambling in adults. There is a lack of evidence for children and young people.

Types of gambling activities

The influence of different types of gambling activities on harmful gambling was explored explicitly by only one study of older gamblers in one review. This reported that problem gamblers tended to play continuous or limitless games such as slot machines and online games. Non-problem gamblers tended to play discontinuous, inexpensive and time-limited games (49).

In summary, there is currently not enough high-quality evidence to attribute type of gambling activity as a risk factor for harmful gambling in adults. There is a lack of review-level evidence on the influence of type of gambling activity on harmful gambling for children and young people, and on gambling for all age groups.

Community influences

Community influences are the characteristics of local areas and cultures, within local spaces or broader social groups, that can influence gambling behaviour.

Seven reviews, 2 of which included a MA, reported on 146 studies that explored community-level risk factors for gambling. Table 6 shows which studies reported on these risk factors. They included:

- accessibility to gambling
- proximity to gambling opportunities
- density of gambling opportunities
- school type

Table 6: Community influences: potential risk factors and number of studies

Risk factor	Reference [number of studies]	Total reviews	Total studies
Accessibility	Wardle 2019a (75) [6]; Wardle 2019b (76) [3]; Subramaniam 2016 (70) [3]; Vasiliadis 2013 (74) [39]; LaPlante 2018 (56) [8]; Guillou 2019 (49) [1]	6	60
School type	Nowak 2018 (64) [65]	1	65
Density to gambling	Vasiliadis 2013 (74) [13]	1	13
Proximity to gambling	Vasiliadis 2013 (74) [8]	1	8

Accessibility

Six reviews reported on 60 studies that examined the relationship between accessibility and gambling or harmful gambling.

One review of 6 qualitative studies focused specifically on young people. It described how young people felt that being able to easily access gambling opportunities locally created opportunities for them to gamble even when they had not planned to (75). This included being able to buy lottery tickets at shops and play gaming machines in pubs and bars. In a review of qualitative studies on gambling in migrant and indigenous populations, the fact that language was not an obstacle made gambling venues feel accessible to migrants. Migrants viewed gambling venues as an available option when there was a lack of other opportunities for spending their free time (76). Two reviews reported that gambling availability may leave older adults more vulnerable to gambling problems (49, 70). Land-based gambling provides an opportunity to socialise (70) and organised transport to and from gambling venues encourages older adults to visit (70).

One review reported that the availability of new gambling activities in communities ('gambling expansion') was associated with changes in gambling and gambling-related problems. But the effects were mixed and varied by gambling outcomes and methodological quality of the included studies (56).

One review reported on the effect of socioeconomic status in the relationship between accessibility and both gambling involvement and problem gambling. The review said that the relationships were unclear and that both need to be explored further (74).
In summary, the body of evidence appears to suggest that accessibility is associated with gambling in children and adults, and harmful gambling in adults. However, the lack of longitudinal evidence and high-quality evidence makes it difficult to come to a strong conclusion about whether it is a risk factor for gambling or harmful gambling for all age groups.

School type

One review with an MA, reported on 65 studies about the association between school type attended and problem or pathological gambling. It concluded that type of third level institution attended (public institution, private college or university, or mixed public and private) did not have any significant influence on the proportion of college students who were pathological or problem gamblers (64).

In summary, the evidence suggests that type of school attended at third level is not associated with harmful gambling.

Density of gambling opportunities

One review, which included 13 studies, explored the relationship between density of physical gambling opportunities and both gambling and harmful gambling. An association between the density of physical gambling venues and increased gambling was reported. There was evidence of more money being spent on gambling in higher density areas, but limited evidence relating to problem gambling (74).

In summary, the available evidence suggests density of gambling opportunities increases gambling, but there is a lack of high-quality review-level evidence for this as a risk factor for harmful gambling. This makes it difficult to reach any conclusions.

Proximity to gambling opportunities

The same review included 8 studies that looked at the relationship between both gambling participation and problem gambling and proximity to gambling venues or gaming machines (74). It reported an association between how close a gambling venue is to a home and increased gambling participation. It also reported that proximity may have a stronger impact on increased problem gambling rates than density of venues or machines (74).

In summary, the available evidence suggests that proximity to gambling may be a risk factor for gambling and harmful gambling, but more high-quality evidence is needed to confirm this.

Family and social influences

Family and social influences are the interpersonal determinants, including formal and informal social networks and social support systems, that can influence gambling behaviour.

Ten reviews, 2 of which included a MA, reported on 115 studies that explored family and social influences on gambling or harmful gambling. Table 7 shows the studies that reported on potential risk factors. These risk factors included:

- family influences
- peer group influences
- child maltreatment
- social support
- intimate partner violence

Table 7: Family and social influences: potential risk factors and number of studies

Risk factor	Reference [number of studies]	Total reviews	Total studies
Family influences	Dowling 2017(15) [2]; McComb 2010 (13) [21]; Wardle, 2019a (75) [5]; Merkouris 2016 (61) [7]; Gyollai 2014 (50) [8]; Levy (2018) (41) [1]	6	44
Peer influences	Dowling 2017 (15) [4]; Wardle, 2019a (75) [7]; Merkouris 2016 (61) [3]; Gyollai 2014 (50) [8]	4	22
Child maltreatment	Lane 2016 (55) [23]; Merkouris 2016 (61) [3]	2	26
Social support	Guillou 2019 (49) [3] Subramaniam 2016 (70)[1]; Merkouris 2016 (61) [3];	3	7
Intimate partner violence	Dowling 2016 (12) [14]	1	14

Peer influences, family influences and social support

Eight reviews, one of which included an MA, reported on 75 studies relevant to peer and family influences and social support.

A peer group is both a social group and a group of people who have similar interests, age, background, or social status. The reviews showed that peers influence some aspects of gambling for young people and older adults. A review of 7 qualitative

studies reported that friends and peer networks influenced young people to start gambling, although one of these studies found that peer influences could also prevent young people from gambling (75). No reviews examined the role of peer influence on gambling in adult populations.

The MA included 4 longitudinal studies relating to peer influences among children and young people. Two of the studies were included in a meta-analysis, which found that experiencing peer antisocial behaviours was a significant risk factor for subsequent gambling problems ($r = 0.12$ (95% CI = 0.07, 0.16) $p<0.0001$) (15).
Among older adults, one review found having limited social support networks was associated with problem gambling (70). Another review included one study that found that older adults frequently visit gambling venues (casinos) to make social connections (49).

There were some contradictory findings for family influences. The MA included 2 longitudinal studies (based on the same dataset) examining parental supervision and reported it as a protective factor against, rather than a risk factor for, subsequent gambling problems for boys ($r = -0.10$ (95% CI = −0.18, −0.03) $p = 0.0079$). Parental supervision was not defined and girls were not participants in either study (15).
Another review reported that a number of parental factors influence adolescent gambling and harmful gambling. These were:

- parental gambling
- parental attitudes towards and involvement in their child's gambling
- parent-adolescent relationships
- parental substance use

Substance use among wider family members was reported as potentially influencing adolescent gambling and harmful gambling. In some included studies the increase in exposure was associated with increased gambling severity.
Family support was positively correlated with gambling risk in female but not male adolescents. Parental factors appeared to be more influential and predictive of gambling behaviour in female than male adolescents. There was a lack of evidence on:

- family sociodemographic characteristics
- family functioning
- parental monitoring and supervision
- family members' attitudes and behaviours
- sibling gambling
- adolescent-sibling relationships

Statistical results from the included studies were not reported (13). A review of qualitative studies reported that gambling can be used as a way to create shared connections among families (75).
One review based on twin studies reported that environmental factors shared by twins, such as having the same friends, school experiences or family environment, did not appear to contribute to developing gambling problems. The authors suggest that genetics played a more significant role than environmental factors.
They reported one exception to this. A study found that these types of environmental factors explained differences in gambling rates in women better than genetics did (50). In relation to gender, low levels of social support had a higher association with problem gambling in women than in men. Low levels of family support were linked with problem gambling in men but not in women (61).
In summary, the evidence suggests that some peer group influences are risk factors for harmful gambling for children and young people. The evidence of this is less strong for gambling in children and young people, and for harmful gambling in older adults. There is a lack of evidence examining peer influences on gambling in adults. Some family influences may work as protective factors for children and young people, but others may be associated with gambling or harmful gambling for adolescents. The lack of high-quality review-level evidence and longitudinal studies makes it difficult to come to a strong conclusion about whether they are risk factors for gambling or harmful gambling. There is a lack of review-level evidence examining family influences for adults. There was not enough evidence available to find out whether lack of social support is a risk factor for gambling or harmful gambling for any age group.

Intimate partner violence and child maltreatment

Three reviews, one which included an MA, included 40 studies exploring the link between IPV victimisation, IPV perpetration or child maltreatment and harmful gambling. We did not find any reviews that examined this for gambling.

The review that included an MA reported on 14 studies (4 included in each MA). This review found a bidirectional relationship between IPV and problem gambling (12). The results of the MA showed that 38.1% of problem gamblers were victims of IPV (95% CI = 28.6, 48.5) and 36.5% of problem gamblers were perpetrators of IPV (95% CI = 25.8, 43.4). The review also reported a high representation of problem gambling in samples of perpetrators of IPV at 11.3% (95% CI = 2.2, 41.6). This would be an over-representation compared to the proportion of problem gamblers in the general population.
Narrative subgroup analysis reported that factors such as less than full employment and chronic and pervasive anger problems were implicated in the relationship between IPV victimisation and problem gambling. Younger age, less than full employment, clinical anger problems, impulsivity, and alcohol and substance use were implicated in the relationship between problem gambling and IPV perpetration.

A review of 23 cross-sectional studies investigated various forms of maltreatment experienced in childhood and their impact on problem gambling. Most studies reported significant positive associations between different types of maltreatment (including sexual abuse, physical abuse and neglect) and later adult gambling problems. This association decreased or disappeared when controlling for mental health problems, except for sexual abuse, which was associated with an increased risk of problem gambling (55).

Results relating to gender differences in the relationship between problem gambling and IPV were inconsistent across the included studies. Similarly results relating to gender differences in the relationship between child abuse and risk of adult gambling lacked coherence. Studies reported that female problem gamblers had experienced significantly more childhood abuse than male problem gamblers, or reported no relationship between gender and problem gambling (55, 61).

In summary, the evidence suggests that child maltreatment may be associated with subsequent harmful gambling. There was a lack of evidence relating to gambling. While there is evidence of an association between IPV perpetration and IPV victimisation and problem gambling, it is difficult to come to a conclusion given the bidirectional evidence. More high-quality review-level evidence and longitudinal data is needed for both.

Individual level influences

The individual level influences are split into 2 sections. They are distal individual level influences and proximal individual level influences.

Distal individual influences

Distal individual influences are risk factors that lie in the background and have an important influence early on in someone's life, before they start gambling. Some vary over time and some can be modified by interventions.

Twenty-three reviews, 11 of which included an MA, reported 602 studies that discuss 15 distal individual influences. These range from impulse control and decision making to emotional regulation and risk behaviours. Table 8 shows the studies that look at these potential risk factors.

Table 8: Distal individual influences: potential risk factors and number of studies

Risk factor	Reference [number of studies]	Total reviews	Total studies
Impulsivity	Kyonka 2018 (54) [12]; Ioannidis 2019 (52) [52]; MacLaren 2011 (57) [44]; Kovács 2017 (53) [7]; Chowdhury 2017 (46) [20]; Amlung 2017 (44) [14]; Smith 2014 (68) [8]; Merkouris 2016 (61) [2]; Dowling 2017 (15) [10]; Marchetti 2019 (58) [2] Levy 2018 (41) [1]	11	172
Gender	Dowling 2017 (15) [6]; Nowak 2018 (64) [58]; Wardle, 2019a (75) [2]; Merkouris 2016 (61) [29]; Subramaniam 2016 (70) [3]; Loo 2019 (42) [1]	6	99
Age	Dowling 2017 (15) [2]; Nowak 2018 (64) [70]; Wardle 2019b (76) [16]; Subramaniam 2015 (70) [2]; Loo 2019 (42) [1]; Guillou 2019 (49) [2]	6	93
Ethnicity	Nowak 2018 (64) [70]; Wardle 2019a (75) [1]; Wardle, 2019a (75) [1]; Subramaniam 2016 (70) [1]; Loo 2019 (42) [3]	5	76
Emotional regulation	Marchica 2019 (59) [14]; Dowling 2017 (15) [1] Marchetti 2019 (58) [20]	3	35
ADHD	Theule 2016 (71) [24]; Dowling 2017 (15) [2]	2	26
Genetics	Gyollai 2014 (50) [21]; Levy (2018) (41) [2]	2	24
Risk perception	Spurrier 2014 (69) [16]; Merkouris 2016 (61)[1]	2	17
Compulsivity	Van Timmeren 2018 (73) [29]	1	29
Ego strength	Levy 2018 (41) [2]	1	2
Coping styles	Wardle 2019b (76) [2]	1	2
Risk taking	Dowling 2017 (15) [4]	1	4
Poor academic performance	Dowling 2017 (15) [2]	1	2
Religion	Dowling 2017 (15) [2]	1	2
Cognitive distortions	Guillou 2019 (49) [1]	1	1

Impulsivity

Impulsivity is defined as an unplanned or 'spur of the moment' reaction to stimuli without considering the potential consequences (even if they are negative) and is a predisposition among certain people (77, 78). Impulsivity can be assessed in different ways, usually by measuring a person's response to a stimulus or a task (for example, measuring ability to control an urge to act) (52). Eleven reviews, 8 of which included an MA, reported on 172 studies examining the influence of impulsivity, or characteristics that are largely synonymous with impulsivity. These characteristics were:

- self-control
- under-controlled temperament
- activation control
- sensation seeking

One MA investigated attentional inhibition, which relates to the ability to suppress aspects of a task that are not relevant, even when they are more obvious or habitual responses (79). Gambling disorder was associated with significant attentional impulsivity (measured using the Stroop effect test), with a medium effect size (hedge's g = 0.55 (CI = 0.23,0.87), p = 0.001) (52).

Three MAs examined motor inhibition (stopping yourself from 'acting without thinking') and the findings were coherent (46, 52, 68). One concluded that gambling disorder was associated with increased impulsivity on Go/No-Go task motor inhibition (hedge's g = 0.39 (CI = 0.15, 0.63), p < 0.001) (52). Another found that pathological gamblers were less able to stop themselves acting without thinking in the Stop Signal Task for gambling (hedge's g = 0.625 (CI = 0.415, 0.835), p < 0. 001) (68). The third study found that that problem gamblers had increased motor impulsivity compared to people with no gambling disorder. Problem gamblers:

- rated themselves higher on self-reported motor impulsiveness (with large effect sizes)
- needed more time to stop an already initiated response (with moderate to large effect sizes)
- were more likely to fail to withhold a response to a Go/No-Go task stimulus (with small to moderate effect sizes) (46)

Two meta-analyses reported coherent findings when investigating 2 forms of discounting: In psychology, discounting refers to how someone attributes a cause to an eventual outcome. The 2 forms of discounting were:

1 Low probability discounting. This is where someone makes risky choices, favouring a large positive outcome even if its probability is low.

2 Delay discounting. This is where someone is able to delay gratification.

One MA reported that lower probability discounting was significantly associated with more intense gambling (hedges' g = 0.36 (95% CI = 0.21,0.50), p < 0.001) (54). The other MA reported a relationship between delay discounting and gambling (r = 0.16, (95% CI = 0.15, 0.18) p < 0.001), but there was heterogeneity across studies (44).

Two further MAs examined decision making tasks and their findings were coherent. One found that gambling disorder (hedge's g = 0.63, (95% CI = 0.50, 0.76); p < 0.001) and problem gambling (hedge's g = 0.66, (95% CI = 0.45, 0.87), p < 0.001) were associated with impaired decision-making with a medium effect size . The authors noted that the quality of the included studies was low (52). The other MA concluded that patients with gambling disorder showed worse decision-making than controls (Cohen's d = -1.034, (95% CI = -156.1, -0.50) p < 0.001) (53). In a review of gambling in veteran populations, self-control was reported to be lower in gamblers than comparison groups (41).

One MA examined the association between some personality traits and gambling. It concluded that several personality traits were associated with pathological gambling. These were:

- unconscientious disinhibition (Cohen's d = 0.79, (95% CI = 0.54, 1.04))
- low premeditation (Cohen's d = 0.84, (95% CI = 0.65,1.02))
- negative affect (Cohen's d = 0.50, (95% CI = 0.30, 0.71))
- negative urgency (Cohen's d = 0.99, (95% CI = 0.69, 1.29))
- disagreeable disinhibition (Cohen's d = 0.50, (95 % CI = 0.26, 0.74))

No p-values were reported. Low perseverance, sensation seeking, and positive affect were not associated with pathological gambling (57).

One MA examined several variables that might influence the strength or the direction of relationship between impulsivity and gambling. Age did not influence the strength of the relationship, apart from evidence that discounting deficits were more pronounced for adult studies compared to a youth study. The results did show geographical differences, with larger discounting deficits found in European studies compared with Asian studies. Discounting deficits were larger for USA studies than for European studies. Also, studies including both male and female participants had larger discounting deficits than studies that included only males (52). One study in a review found that impulsivity may influence the relationship between gambling and gambling severity, but another study did not find an association (58).

One review examined gender differences in the effect of impulsivity on problem gambling and evidence was not coherent. Of the 3 included studies exploring

impulsivity, 2 studies found that impulsivity predicted problem gambling for males but not females (61).

One review with an MA of longitudinal studies of children and young people found impulsivity was a significant risk factor for problem gambling (r = 0.21 (95% CI = 0.11, 0.30) p<0.0001). Small effect sizes were found in studies of adolescents or young adults compared to those covering children as well, but the authors were confident the results were consistent due to the overlap of confidence intervals (15).

This review also examined the relationship between gambling and under-controlled temperament in children. This is a form of impulsivity defined as children who were rated as having less control behaviourally or emotionally in terms of restlessness, wilfulness, and several other indicators (80). The authors concluded that under-controlled temperament at age 3 was significantly associated with problem gambling later in life (r = 0.22 (95% CI = 0.13 0.31) p < 0.0001) (15), which is consistent with the findings around impulsivity. This review also looked at a the related characteristic, activation control, defined as “the capacity to perform an action when there is a strong tendency to avoid it” and subsequent problem gambling, but they found no significant association (r = −0.03 (95% CI = −0.19, 0.12) p = 0.7189) (15).

Sensation seeking is a form of impulsivity, defined as “the search of varied, novel, complex and intense feelings and experiences, and readiness to take physical, social, legal, and financial risks for the sake of such experiences” (81). Two reviews, both of which included an MA, reported on 22 studies that explored the relationship between sensation seeking and problem gambling with mixed results. One MA concluded that sensation seeking was a significant risk factor for problem gambling in children and young people based on 2 studies (r = 0.02 (95% CI = 0.01, 0.04) p = 0.0009) (15). The other MA, based on 20 studies, found no evidence of reliable associations between problem gambling and sensation seeking forms of impulsivity in adults (Cohen’s d = 0.11, (95% CI = −0.11, 0.32)). No p-value was reported (57).

In summary, the large body of evidence suggests that impulsivity (including under-controlled temperament and sensation seeking) is associated with both gambling and harmful gambling for adults. There is also evidence it is a risk factor for harmful gambling for children and young people. Evidence suggests that sensation seeking is not associated with harmful gambling in adults. But as there are no longitudinal studies it is not possible to tell if impulsivity is a cause of gambling in all age groups, or of harmful gambling in adulthood.

Gender

We use the term ‘gender’ here as this term was used in primary studies, but it was often used interchangeably with sex.

Six reviews, 2 of which included an MA, reported on 99 studies relevant to the relationship between gender and gambling or harmful gambling. One review, based on US survey data, reported that men were generally more likely to gamble than women. But this relationship was influenced by age, ethnicity and mental health (42). A review of qualitative studies among young people reported a lack of evidence on the role of gender in gambling involvement (75).

A high-quality review focused on children and young people identified male gender as associated with subsequent problem gambling in an MA of 6 longitudinal studies ($r = 0.24$, (95% CI = 0.16, 0.33) $p < 0.0001$) (15). Another MA that focused on college students reported a significant relationship between male gender and pathological gambling ($QM = 6.59$, $p < 0.05$). This MA found no significant association for prevalence of problem gambling (64). Another review reported similar findings in relation to older adults in 3 studies of adults aged over 60 years (70). Another review concluded that gender likely has an indirect rather than direct role in influencing the development of problem gambling along with other factors (61).

In summary, the small body of evidence suggests gender may be associated with gambling participation for adults, but there is a lack of evidence for children and young people. The evidence suggests that male gender is a risk factor for harmful gambling for children and young people and, to a lower degree, for adults.

Age

Six reviews, 2 of which included an MA, reported on 93 studies relevant to the impact of age on gambling or harmful gambling. A review of qualitative studies reported that an age-related milestone (that is, turning 18) could encourage gambling, but equally this could be prevented by lack of money (75).

One review with an MA included 2 longitudinal studies relating to children and young people and the influence of age. No MA was performed on these studies, but the Stouffer's method failed to show an association between age and subsequent problem gambling (15). Another MA, as part of an analysis of factors moderating rates of gambling among college and university students, concluded that prevalence of problem gambling was not influenced by age (64).

Two reviews focused on older adults provided inconsistent results in relation to age. One reported that adults aged under 70 years were at greater risk of problem gambling compared with older adults (70) whereas another reported this to be the case for women over 65 years of age (49). A review based on US survey data found that among people with “subclinical levels of pathological gambling” (no definition given) more men were in the younger age group (18 to 29 years) and more women were in the older age group (65 years and over) (42).

In summary, no evidence was found for the impact of age on gambling involvement for any age group. The evidence suggests that age is not a risk factor for harmful gambling among children and young people. Age related milestones may be associated with gambling, and older age may be associated with harmful gambling among adults. But we could not come to a conclusion for this group because of the small amount of low-quality evidence and lack of longitudinal data. It may also differ by gender.

Ethnicity

Five reviews, one of which included an MA, reported on 76 studies relevant to ethnicity and gambling or harmful gambling. One review of only one study that focused on migrant communities reported that gambling participation was less likely in Asian migrant groups than non-Asian migrant groups (76). A review of qualitative studies described a focus group of Polish young people in Canada, which reported that "…gambling was frowned upon within their community and not part of family or social life" (75). This suggests ethnicity (and associated culture) may affect gambling participation.

The MA, which focused on college and university students, found a significant relationship between the proportion of non-White students and pathological gambling in student populations. The probability of pathological gambling increased by 0.07% with each 1% increase in the proportion of non-White students ($z = 2.384$, $p < 0.05$) (64). Similarly, another review based on US prevalence data reported higher problem or pathological gambling in Black and Native American or Asian adults when compared with White adults. This review found that Hispanic people were slightly less likely to be problem or pathological gamblers than White people (42).

One review of one study identified a higher prevalence of gambling disorder among older African-Americans compared to White Americans (70).

In summary, the small body of evidence suggests that ethnicity may influence gambling participation and some ethnicities may be associated with problem gambling. But we cannot come to any strong conclusion for any age group because of the low numbers and low-quality evidence across a range of population types.

Emotional regulation

Three reviews included 35 studies examining the relationship between the ability to regulate emotion and problem gambling. One review included 14 studies examining this relationship, defining emotional regulation as "…the process by which, how, and when negative and positive emotions are expressed and experienced". It found that 12 of the 14 studies showed a significant association between emotional regulation and problem gambling (59). A review with an MA found that dispositional attention, which relates to how often a person attends to their emotions in everyday life (82),

was not a significant risk factor for problem gambling in children and young people (r = -0.03 [95% CI = -0.23, 0.18] p = 0.8059) (15).

One review of 20 cross-sectional studies investigated the impact of alexithymia on problem gambling. Alexithymia is a personality trait characterised by an inability to identify, describe and process emotions experienced by yourself or others (58). Fourteen studies used community samples and mostly found a higher level of alexithymia in pathological gamblers compared to problem gamblers or healthy subjects. In the 6 clinical samples, 2 studies found significantly higher levels of alexithymia in people with gambling disorder compared to controls. Four studies reported that level of alexithymia significantly predicted the severity of gambling disorder.

In summary, we did not find any evidence of a relationship between a person's ability to regulate emotion and gambling. The small amount of review-level evidence shows emotional regulation (including alexithymia) may be associated with problem gambling in adults, but dispositional attention is not associated with problem gambling in young people. Further high-quality longitudinal evidence is needed to confirm that emotional regulation is a risk factor for all age groups.

Attention deficit hyperactivity disorder

Two reviews, one with an MA, reported on 26 studies relevant to the relationship between attention deficit hyperactivity disorder (ADHD) and harmful gambling. The MA (based on 24 studies) reported a significant relationship between ADHD symptoms and severity of gambling problems (r = 0.17, (95% CI = 0.12, 0.22) p < 0.001). It also reported that problem gambling was almost 3 times more likely in young people and adults with ADHD than those without ADHD (OR = 2.85, (95% CI = 1.89, 4.30) p < 0.001). A moderator analysis revealed this relationship was not influenced by other factors (type and year of publication, country of study and gender), except age. The relationship between ADHD and gambling was stronger with increased age, although this result was not significant (71).

One review (based on an MA of 2 studies) reported that attention problems were not significantly associated with subsequent problem gambling (r = -0.08 (95% CI = -0.33, 0.16) p = 0.5145) (15). But in relation to ADHD they reported that young adults (aged 18 to 25) with ADHD symptoms since childhood were more likely to develop problematic gambling than people without ADHD symptoms (or who's symptoms had stopped since childhood, but no MA was performed on this) (15).

In summary, there was a lack of high-quality review level evidence or longitudinal data for ADHD as an influence on gambling. Overall, the evidence suggests that ADHD may be associated with harmful gambling in children and young people, and in adults. However, further high-quality longitudinal evidence is needed to confirm that ADHD is a risk factor for harmful gambling among all ages.

Genetics

Two reviews included 24 studies relevant to the relationship between genetics and harmful gambling. Both reviews looked at twin studies, one of twins in the general population and one of twins who had served in the military. They found that genetic factors play an important part in the development of problem gambling, but acknowledged that environmental factors also play a role (41, 50).

In summary, we were not able to come to a conclusion on genetics as a risk factor for gambling in any age group because of the lack of high-quality review-level evidence or longitudinal data. The small amount of evidence suggests genetics may play a role in the development of harmful gambling, but more high-quality evidence is needed to confirm this.

Risk taking

One review with an MA reported on 2 studies that investigated experience of sexual risk taking among children and young people. It concluded that it was not a significant risk factor for developing gambling problems ($r = 0.14$ (95% CI = −0.01, 0.29) $p = 0.0766$). The same review reported on 2 studies that found safety related risk taking was not a significant risk factor for developing gambling problems ($r = 0.14$ (95% CI = −0.01, 0.29) $p = 0.0767$) (15).

In summary, from the small amount of high-quality longitudinal review-level evidence, it appears risk taking may not be a risk factor for harmful gambling in children and young people. No evidence was available to reach any conclusions for the impact on gambling among children and young people, or for any outcomes in adults.

Risk perception and cognitive distortions

Risk perceptions are subjective judgments or beliefs people hold about the possibility of a loss (83). Two reviews included 17 studies relevant to the impact of risk perception on gambling or harmful gambling. One review reported that among male adolescents, the perception that gambling was economically profitable predicted participation in gambling (61). Another review included 16 studies that reported that both young people and adults who take part in harmful gambling held more optimistic perceptions of risk related to gambling than people who do not gamble or regular gamblers. But problem gamblers and non-gamblers were more accurate at perceiving harmful outcomes than regular, but less experienced, gamblers. The authors noted that risk perception varied depending on the context or individual (69).

One review looked at gambling-related cognitive distortions, which are ways of thinking that are inaccurate (such as ideas about luck, near misses and chasing wins). The review found that these distortions were associated with continued and escalating gambling behaviour in older adults, but only in one study (49).

In summary, there is a lack of review-level evidence examining the influence of risk perception on gambling or harmful gambling for children, and of the influence of cognitive distortions on children, young people and adults. The lack of high-quality review-level or longitudinal evidence for the impact of risk perception on gambling or harmful gambling among young people and adults means we could not come to a conclusion. The lack of high-quality review-level or longitudinal evidence for the impact of cognitive distortions, on gambling and harmful gambling for older adults means we could not come to a conclusion.

Compulsivity

One MA of 29 studies investigated the influence of compulsivity, which they defined as “the performance of repetitive acts despite the negative consequences”, on harmful gambling (73). They found that people with gambling disorder were not able to undertake several compulsivity-related neuropsychological functions. This was measured by asking them to complete tasks that test their ability to:

- be flexible in learn and unlearn behaviour (cognitive flexibility)
- switch their attention to various stimuli (attentional set-shifting)
- stop themselves choosing an automatic response (attentional bias)

For example, the ‘card playing task’, involved drawing a face card to win money and a number card to lose money. Early in the task there are more face cards, and later there are more number cards. The participant had to decide after drawing each card if the task was still profitable and if they should stop. People with gambling disorder persevered for longer than healthy controls (effect size = 0.569; $Z=3.776$, $p < 0.001$). They also made more errors on the ‘Wisconsin card sorting test’ due to persisting (effect size = 0.518; $Z = 5.895$, $p < 0.001$). This tested participants’ cognitive flexibility by asking them to sort cards using certain rules and then the rules changed after a certain time. People with gambling disorder also performed significantly worse on the ‘trail making test’, which required them to shift and connect sets of letters and dots as fast as possible, while maintaining accuracy (effect size=0.270, $Z = 2.175$, $p = 0.030$) (73).

In summary, there is a lack of review-level evidence examining the influence of compulsivity on gambling involvement for all age groups. The evidence suggests that compulsivity is associated with harmful gambling in adults, but more high quality and longitudinal evidence is needed to determine if it is a risk factor for harmful gambling. There is a lack of review-level evidence examining this in children and young people.

Ego strength and coping styles

Ego strength refers to an internal resilience or strength, and the extent to which we learn to face and grow from challenging events in life (84).

One review of veteran populations cited 2 studies that found that ego strength was significantly lower among gamblers than the standardised group norm in one study and the control group in a second study (41).

One review reported 2 studies that found gambling may be used as a coping strategy by immigrants in Australia. One study suggested it may be due to trauma experienced before moving (76).

In summary, there was no review-level evidence found for children and young people. The lack of high quality review-level or longitudinal evidence for the impact of ego strength and coping styles on gambling or harmful gambling means we could not come to a conclusion for adults.

Poor academic performance

One review with an MA, focused on children and young people, found that poor academic performance was a significant risk factor for subsequent problem gambling (r = 0.24 (95% CI = 0.09, 0.39) p = 0.0021). This was based on 2 longitudinal studies (15).

No reviews examined poor academic performance in adults. This is not unexpected as academic performance is usually a childhood or young adulthood experience.

In summary, there is a lack of review-level evidence examining the influence of poor academic performance on gambling. From the small amount of high-quality longitudinal review-level evidence, it appears poor academic performance may be a risk factor for harmful gambling in children and young people.

Religion

One review with an MA, focused on children and young people, reported that attending religious services was not a significant risk factor for later problem gambling (r = 0.09 (−0.11, 0.29) p = 0.3698). This was based on 2 longitudinal studies (15). No reviews examined the role of religion in gambling for adult populations.

In summary, from the limited high-quality longitudinal review-level evidence, it appears that religious attendance may not be a risk factor for gambling in children and young people. Further research is needed to confirm this. No evidence was available to reach any conclusions for outcomes in adults.

Proximal individual influences

Proximal individual influences are risk factors that often present later in life (sometimes combined with distal factors) and influence gambling initiation (if it has not started) or escalation. These can change over time and can potentially be changed through the action of policies and interventions.

Eighteen reviews, 3 of which included an MA, reported 276 studies relevant to 18 proximal individual risk factors. Table 9 shows the studies that look at these potential risk factors.

Table 9: Proximal individual influences: risk factor by review

Risk factor	Reference [number of studies]	Total reviews	Total studies
Substance use (alcohol, drugs and tobacco)	Dowling 2017 (15) [11]; Peters 2015 (65) [10]; Merkouris 2016 (61) [16]; Scholes-Balog 2012 (67) [3]; Levy (41) [3]; Guillou 2019 (49) [1]	6	44
Mental health problems	Dowling 2017 (15) [13]; Durdle 2008 (47) [18]; Scholes-Balog 2012 (67) [12]; Merkouris 2016 (61) [16]; Loo 2019 (42) [2]; Guillou 2019 (49) [2]	6	63
Marital status	Subramaniam 2016 (70) [2]; Loo 2019 (42) [1]; Guillou 2019 (49) [1]; Merkouris 2016 (61) [8]	4	12
Neurological disorders treatment	Grall-Bronnec 2016 (48) [65]; Molde 2018 (63) [14]	2	79
Income	Subramaniam 2016 (70) [2]; Guillou 2019 (49) [3]	2	5
Employment	Merkouris 2016 (61) [9]; Wardle 2019a (75) [1]	2	10
Physical health	Loo 2019 (42) [3]; Guillou 2019 (49) [2]	2	5
Money spent/lost/won	Dowling 2017 (15) [4]; Wardle, 2019a (75) [5]	2	9
Socioeconomic status	McComb 2010 (13)[3]; Merkouris 2016 (61) [2]	2	5
Age of onset	Dowling 2017 (15) [4]	1	4
Number of gambling activities	Dowling 2017 (15) [2]	1	2
Antisocial behaviour	Dowling 2017 (15) [4]	1	4
Personal relative deprivation	Callan 2015 (45) [8]	1	8

Risk factor	Reference [number of studies]	Total reviews	Total studies
Trauma	Levy 2018 (41) [5]	1	5
Problem gambling severity	Dowling 2017 (15) [5]	1	5
Violence	Dowling 2017 (15) [2]	1	2
Aggression	Dowling 2017 (15) [2]	1	2
Acculturation	Wardle 2019b (76) [12]	1	12

Substance use (including alcohol, drugs and tobacco)
Five reviews, one of which included an MA, included 44 studies examining the links between substance use and gambling or harmful gambling. One review examined this as a risk factor for gambling.

In relation to gambling, one review focused specifically on the relationship between substance use and gambling for adolescents in the US. It reported relationships between using alcohol, tobacco and illegal drugs and gambling based on 10 cross-sectional studies (65).

For harmful gambling, one MA focused on children and young people and included 11 longitudinal studies relevant to substance use. Frequency of alcohol use (r = 0.19, (95% CI = 0.15 – 0.22)), tobacco (r = 0.14, (95% CI = 0.10 – 0.18)), cannabis (r = 0.15, (95% CI = 0.12 – 0.19)) and other illegal drugs (r = 0.14, (95% CI = 0.11 – 0.17)) were significantly associated with problem gambling later in life ($p<0.0001$ for all associations) (15).

A further 3 reviews supported these results across different combinations of substances and for different populations. One reported associations between the use of various substances and problem online gambling (67). Another reported that rates of gambling disorder were significantly higher among veterans with comorbid substance use disorders than those without substance use issues (41). One further review cited a study that noted that older adult problem gamblers people with a history of problem gambling were significantly more likely to have alcohol use disorder and be tobacco dependent (49). However, these reviews did not provide full details of the included studies.

One review exploring gender differences reported that in 4 studies male problem gambling was consistently associated with alcohol use among adults and adolescents. One study included in this review found that alcohol use was associated with gambling problems in both males and females. Another study found that alcohol-related problems were associated with gambling problems in females, but not males.

The same review included 3 studies that found higher prevalence of substance-related disorders (not specific) in males. The review found no significant gender differences for:

- tobacco use (based on4 studies)
- nicotine dependence (based on 3 studies)
- cannabis or cocaine abuse or dependence (based on one study)
- prescription drug use (based on one study)

One study found cannabis use was associated with problem gambling in both males and females (61).

In summary, the evidence suggests that substance use is a risk factor for harmful gambling among children and young people. Substance use may be associated with gambling in children and young people, and harmful gambling in adults, but, because of the lack of longitudinal data, we cannot come to any definite conclusions.

Mental health problems and neurological disorders treatment
Eight reviews, 3 of which included an MA, reported on 142 studies relevant to mental health problems and neurological disorders treatment.

One MA included 12 longitudinal studies relating to mental health problems among children and young people, 6 of these studies were included in the meta-analysis. It reported a significant association between having symptoms of depression and problem gambling (r = 0.15 (95% CI = 0.03, 0.27) p = 0.0164). The meta-analysis found non-significant effects for anxiety, psychological distress, suicidal ideation and negative affect (negative emotions) (15). Another MA reported a strong association between pathological gambling and obsessive-compulsive traits (effect size = 1.01). It found a weaker association between problem gambling and obsessive-compulsive disorder (effect size = 0.07) and obsessive-compulsive personality disorder (effect size= 0.23). The authors did not report the study populations and noted that the quality of included studies was weak (47).

Three reviews support these results. One review based on US survey data reported on one study that found that problem gamblers were more likely to report lifetime psychiatric disorders. Another study found increased odds of the incidence of some mental health conditions (mood and anxiety disorders) at the 3 year follow up among people reporting any gambling behaviour at the beginning of the study (42). Authors of a review of 12 studies concluded that while there was a relationship between problem online gambling and mental health problems, the research was limited, sometimes inconsistent and the direction of the relationship was unclear (67).

A further review described links between mental health problems and harmful gambling. It reported associations between life-long problem gambling and mental

health problems such as mood disorders, anxiety disorders and avoidant personality disorder among older adults (49). But the review provided little detail about the study design, methods or possible biases.

Gender differences in the relationship between mental health problems and harmful gambling were reported, but results lacked coherence. One review based on 16 studies reported inconsistent findings for gender differences in the association between mental health and problem gambling. This included mood disorders, anxiety disorders and depression (61). Another review reported on one study that found stronger associations between pathological gambling and mental health problems among women compared to men (42).

The same review also reported a greater association between pathological gambling and mental health among American Indian and Alaskan Native adults compared to other ethnic groups based on one study (42).

Two reviews investigated the link between Parkinson's disease and harmful gambling. One MA of 14 case-control studies reported that gambling disorder was significantly associated with Parkinson's disease treatment. People with Parkinson's disease were almost 3 times more likely to gamble than a healthy control group (OR = 2.70, (95% CI = 1.56, 4.67)) (63).

Another review of 65 French case reports investigated whether problem or pathological gambling could result from an adverse drug reaction, specifically to the dopamine aripiprazole (ARI) or dopamine replacement therapy (DRT), which are both often used to treat Parkinson's disease. The review concluded it was highly possible for both treatments, reporting that gambling disorder was likely due to dopamine in 16 of 17 ARI cases and in 46 of 48 DRT cases identified. This has implications for the potential relationship between Parkinson's disease and harmful gambling, although the authors noted that individual and environmental factors could also have played a part in these people developing gambling problems (48).

In summary, the evidence suggests that medication for Parkinson's disease can lead to harmful gambling in adults. There is longitudinal evidence that symptoms of depression are a risk factor for harmful gambling in young people, but anxiety, psychological distress, suicidal thoughts and negative affect are not. The lack of high-quality longitudinal evidence makes it difficult to state whether mental health problems are risk factors for harmful gambling in adulthood. The relationship appears to be bi-directional.

Marital status

No reviews examined the relationship between marital status and gambling. Four reviews reported on 12 studies relevant to the relationship between marital status and harmful gambling. Three reviews reported links between being single, separated,

divorced or widowed and harmful gambling among older adults (49, 70) and adults in the USA (42). But, none of these 3 reviews cited more than 2 studies and most provided little detail on the study type or quality.

In summary, there is not enough evidence to determine if marital status is a risk factor for gambling or harmful gambling.

Income and employment

Four reviews reported on 15 studies relevant to the relationship between income or employment and gambling or harmful gambling. The reviews show that there are links between income or employment and gambling in young people, older adults and migrant communities (49, 75, 76). There are also links between income or employment and harmful gambling in older adults (70). For example, one review reported that older gamblers increased participation in gambling after retirement to make up for loss of income, or to make money (49). Another review identified income as a risk factor for problem gambling in older adults (70). However, most of the findings were based on a limited number of studies and provided little detail of study type or quality. So, while income and employment were described as predictors or risk factors, it was often unclear how this assessment had been made.

Gender differences related to the relationship between income, employment and gambling were described by one review. It reported that 3 out of 9 studies exploring occupational status found unemployment to be more common in female compared to male problem gamblers. Another of the cited studies reported that females were more likely to have gambling problems if they were employed, but the study did not report any causal pathways. There was no similar association between employment and problem gambling found for males (61).

In summary, the lack of high quality review-level evidence or longitudinal data for income or employment as risk factors for gambling or harmful gambling means it is difficult to make any conclusions.

Socioeconomic status and personal relative deprivation

Three reviews, one of which included an MA, reported on 13 studies relevant to socioeconomic status or personal relative deprivation and gambling at varying levels. Personal relative deprivation is the belief that you are deprived compared to others.

The MA investigated this and the impulse to gamble reporting a significant association across 8 studies (random effects, $r = 0.261$, $Z = 6.43$, $p < 0.0001$; fixed effects: $r = 0.263$, $Z = 7.78$, $p < 0.0001$). The relationship was stronger at higher levels of problem gambling severity (45). One review cited 3 studies that found that socioeconomic status, measured by family income and/or parental education, had a minor relationship with gambling among adolescents but the review did not report the types of studies this was based on (13).

There were gender differences reported in the relationship between socioeconomic status and gambling. One review reported that socioeconomic status was related to female only gambling, but the review did not say whether this related to low or high socioeconomic status (13). In terms of harmful gambling, a review reported that low socioeconomic status was related to male only problem gambling (61). These reviews were based on one study each.

In summary, evidence suggests there may be an association between personal relative deprivation and gambling, which is stronger at higher levels of problem gambling severity across age groups. Socioeconomic status may be associated with gambling in adolescents, but because of the small amount of low-quality evidence, we cannot come to a conclusion.

Age of gambling onset, number of gambling activities, money spent, won or lost, and problem gambling severity

Two reviews, one of which included an MA, reported on 20 studies exploring the relationship between gambling or harmful gambling and:

- age of gambling onset
- number of gambling activities
- money spent, won or lost
- problem gambling severity

A review of qualitative studies described 4 studies that found that gambling among young people appeared to be about more than just the risk and reward of winning or losing money. The author concluded that this needed to be explored further. One included study explored gender differences around the fear of losing money by gambling. Girls argued that they gamble less because they were smarter with money than boys and were less interested in ‘giving their money away’. Boys felt they had more disposable income, so the fear of losing through gambling was less of a concern to them (75).

The review that included an MA focused on children and young people and included 5 longitudinal studies which explored the impact of problem gambling severity on subsequent problem gambling among younger people. It concluded that problem gambling severity was significantly associated with subsequent problem gambling among young people ($r= 0.40$ (95% CI = 0.26, 0.54) $p < 0.0001$) (15). The same review included 2 longitudinal studies relating to the number of gambling activities children and young people participated in. It reported a significant association with later problem gambling ($r = 0.19$ (95% CI = 0.14, 0.24) $p < 0.0001$) (15). The review also reported on 4 longitudinal studies looking at the impact of a person’s age of first experience of gambling. The MA found no significant association between age of

gambling onset and later problem gambling (r = 0.13 (95% CI = −0.01, 0.28) p = 0.0762) (15).

The same review included 4 studies related to big early losses or wins among children and young people and concluded that neither were significantly associated with problem gambling (15). But the MA only included the 2 studies examining wins (r = 0.03 (95% CI = -0.29, 0.36) p = 0.8416). No MA was performed on the 2 studies examining losses, but the Stouffer's method was used, and it did not show that there was a significantly positive association with problem gambling.

In summary, the available evidence suggests that problem gambling severity and the number of gambling activities participated in are risk factors for subsequent harmful gambling for younger people. Age of onset and money won or lost are not risk factors for subsequent harmful gambling among young people. More high-quality evidence is needed to examine the link between gambling and money spent, won or lost across all age groups. There is a lack of evidence exploring problem gambling severity, and whether the number of gambling activities participated in is a risk factor for subsequent harmful gambling in adults, or for gambling in all age groups.

Physical health

Two reviews reported on 5 studies that explored the relationship between physical health and harmful gambling, with one of these reviews also reporting on gambling, all in adults.

One review based on US survey data cited one study that found an association between higher problem gambling severity and obesity, as well as self-reported poorer health. Another study found that prevalence of problem gambling was higher for people with moderate or severe pain interference (pain that stops someone from engaging in activities or enjoying life) than for people with no or low pain interference. The authors also reported on a third study that found that recreational gambling among older adults was associated with obesity, and also with better physical and mental health, but no further detail was included to explain this (42).

Another review of older adult gamblers cited 2 studies that found that older adults with gambling problems reported more significant co-existing health issues than non-gamblers or non-problem gamblers. The review discussed possible reasons for this, for example the sedentary nature of gambling leading to health issues, but these were not formally examined (49).

In summary, the lack of high-quality review-level evidence or longitudinal data for physical health as a risk factor for gambling or harmful gambling means it is difficult to make any conclusions at this stage.

Anti-social behaviours, violence and aggression

No reviews examined anti-social behaviours, violence or aggression relating to gambling. One review, which included an MA, reported on 8 studies relating to anti-social behaviours, violence or aggression and harmful gambling.

The MA included 4 studies that looked at the impact of antisocial behaviours on problem gambling among children and young people. It found that anti-social behaviour had a small but significant association with subsequent problem gambling ($r = 0.07$ (95% CI = 0.01, 0.04) $p = 0.0264$). It also included 2 longitudinal studies that investigated the relationship between violence and problem gambling among children and young people, and 2 studies that investigated aggression. It concluded that being violent was significantly associated with subsequent problem gambling ($r = 0.12$ (95% CI = 0.06, 0.17) $p = <0.0001$) but no significant association was found for aggression ($r = 0.03$ (95% CI = −0.31, 0.24) $p = 0.8183$) (15).

In summary, from the limited high-quality longitudinal review-level evidence, it appears that anti-social behaviour and violence may be risk factors for harmful gambling in children and young people, but aggression is not. No evidence was available to reach any conclusions for a relationship between these risk factors and harmful gambling in adults or gambling for any age group.

Trauma (including PTSD)

One review of veteran populations cited 5 studies that examined the relationship between traumatic experiences and harmful gambling, but the nature of the relationship was unclear. Three studies found high rates of gambling or problem gambling in veterans with post-traumatic stress disorder (PTSD) but no association between them. Another study reported a higher incidence of traumatic life events among respondents with a gambling problem than those without. Witnessing someone being injured or killed as well as experiencing a physical attack were also significantly associated with problem gambling. The review found no association between problem gambling and exposure to combat situations. Another study found that veterans recently returned from military duty in Iraq and Afghanistan were more likely to engage in problem gambling if they had a PTSD diagnosis than those without a diagnosis (41).

In summary, the evidence suggests that trauma is associated with harmful gambling in adults. But the lack of high-quality review-level evidence or longitudinal data make it difficult to make strong conclusions about whether it is a risk factor for harmful gambling. We found no evidence in relation to gambling for all age groups, or gambling in children and young people.

Acculturation

Acculturation is defined as “the process that individuals undergo in response to a changing cultural context” (76).

No reviews examined acculturation in relation to harmful gambling. One review of qualitative studies focused on migrant populations and reported on 12 studies relating to acculturation and gambling. The authors found that acculturation difficulties may influence migrants' gambling. This includes:

- not being proficient in the language of a new country
- lack of suitable leisure activities
- difficulties with fitting into the new society
- feeling under pressure to send money to family back home
- experiences of negative life events
- social isolation
- other immigration-related problems (76)

In summary, the lack of high quality review-level evidence or longitudinal quantitative data for the impact of acculturation on gambling means it is difficult to make any conclusions at this stage. We found no evidence relating to harmful gambling.

Neurological influences

Given the purposely wide scope of our search, we identified evidence of neurological characteristics that influence gambling, but these fall outside our conceptual model (see Table 10). We've included a summary of findings related to these influences here but have not explored them further in the discussion.

Table 10: Neurological influences: risk factors by review

Risk factor	Reference [number of studies]	Total reviews	Total studies
Attentional bias and cue reactivity	Van Holst 2009 (72) [8]	1	8
Decision making and executive function	Van Holst 2009 (72) [2]	1	2
Reward and punishment sensitivity	Van Holst 2009 (72) [7]	1	7
Higher activation of the fronto-striatal circuit	Quaglieri 2020 (66) [21]	1	21
Hyperactivity in the lentiform nucleus	Meng (60) [2014]	1	13
Impaired activity in prefrontal areas	Moccia (62) [2017]	1	14

Neuroanatomical (circuits underlying cognitive and behavioural function)

Neuroanatomical relates to the structure and organisation of the nervous system (85). One MA of 21 experimental studies found that gambling disorder was mainly associated with activation of the part of the brain responsible for reward. People with gambling disorder also showed greater activity in the bilateral dorsal striatum, which is linked to stronger action–outcome associations. This could be explained by an overestimation of the gambling outcomes (66).

Similarly, an MA of 13 neuroimaging studies concluded that, compared with healthy controls, patients with gambling disorder had significant hyperactivity in the lentiform nucleus. This forms part of a complex structure in the centre of the brain that coordinates extensively with other regions for example, the prefrontal cortex. It also contains the dopamine projection that plays an important role in both movement (Parkinson's disease) and reward (addiction) (60).

The results of an MA of 14 neuroimaging studies indicated that impaired activity in prefrontal areas may account for impaired cognitive control. This could contribute to some features of problem gambling, such as the progressive loss of control over gambling behaviours (62).

Neurocognitive functions (individual responses underlying learning and behaviour)

Neurocognitive functions are specific workings in the brain affected by different disease processes (86).

One review of cognitive and neuroimaging findings in pathological gamblers found that pathological gamblers have similar neurobiological abnormalities to people with other addictions. The most consistently reported abnormalities were:

- abnormal reward and punishment sensitivity
- disadvantageous decision making
- diminished inhibition

There was less consistent information on cue reactivity and attentional bias.

The review described 7 studies that concluded that problem gambling was characterised by increased reward seeking behaviour and decreased sensitivity to loss based on behavioural tasks. It's not yet clear if reduced reward and punishment sensitivity is a consequence or precursor of gambling (72)

Inequalities

The reviews highlighted a broad range of risk factors relating to inequalities and gambling outcomes. For example:

- socioeconomic status and personal relative deprivation
- income and employment

- community factors such as density or proximity to gambling
- gender, age and mental and physical health
- vulnerable groups such as older adults and migrant populations

But when we examined the reviews for characteristics that influenced the relationships between the risk factors and gambling outcomes there was very little reporting of evidence relating to inequality. The reviews examined findings for gender as an influencer of gambling outcomes most frequently, but results were often mixed and not coherent. A small number of reviews investigated other characteristics such as age, country of study, and socioeconomic status. Review authors often pointed to not having enough data to analyse the impacts of these (15, 59, 71).

4. Discussion

This report represents an overview of the current systematic review-level evidence base of potential risk factors for gambling. Synthesising review-level evidence enabled us to identify and examine the breadth of potential risk factors. The results section broadly shows the strength and nature of the evidence for each potential risk factor. This section critically assesses the evidence as a whole. This includes the gaps observed, limitations, and implications for research and policy.

4.1 Summary of findings

We identified a large number of reviews (n = 39), covering a wide range of populations, countries and potential risk factors for either gambling (n=7), harmful gambling (n = 28) or both (n = 4). However, we assessed the overall quality of reviews as critically low. All but one had serious methodological weaknesses, mostly related to a lack of protocols, no quality assessment of included studies, and to a lesser extent issues with conflict of interest. Many reviews presented narrative results sections with limited information on the design, methods and results of included studies. This made it difficult to know how review authors had reached their conclusions and how accurate (or reliable) the reported results were.

Very few reviews (n = 5) included longitudinal studies. Most relied on cross-sectional evidence and reported associations. Often results were reported without being backed up by data or statistical analyses. This made it difficult to determine the direction of the relationship between a potential risk factor and gambling or harmful gambling. This reliance on cross-sectional studies may be because this is a relatively new research topic and more pragmatic research methods can be used to begin to understand an issue. But equally it could be a result of limited research funding

Whatever the case, it means that how we view gambling related risk is based for the most part on cross-sectional evidence, which does not necessarily establish risk (that is, that the potential risk factor occurred before gambling). We have clearly stated when causality cannot be confirmed for this reason. The theoretical framework underpinning this work ensured that potential risk factors were plausible but relying on associations is an issue where a relationship could be bi-directional. For example, this might be the case for mental or physical health problems (42, 49, 67) and impulsivity (54, 57).

Although this is the first umbrella review of risk factors for gambling, other studies and papers have presented overviews of literature on risk factors for harmful gambling. Some of these describe risk factors that were not identified in this umbrella review, potentially due to a lack of evidence at the systematic review level. For example, a critical literature review of risk factors for problematic gambling found additional

proximal risk factors for gambling. These were reported as societal risk factors and included residence (living in a large city), heart rate and arousal when gambling, and additional sensory characteristics to speed of play (such as sound) (14). Similarly, a survey of risk factors for gambling-related harm identified additional proximal risk factors such as excitement and escape, as well as distal risk factors such as being dependent on another adult for primary care (87). It is possible that we did not identify these risk factors because any evidence related to them is only in primary studies, and so was not included using our review of reviews approach.

Most of the reviews focused on individual-level risk factors, and there was a lack of evidence on the impact of family and social, community or societal factors on subsequent gambling or harmful gambling. This might reflect that gambling was viewed as a mental disorder until relatively recently. The call for a public health approach to gambling has only happening in the last few years (2, 88).

4.2 Confidence in the evidence

We considered our confidence in the findings throughout the results section, based on the 4 principles of CERQual. This involved looking at the included studies':

- methodological limitations
- relevance
- coherence
- adequacy

We have summarised this below based on whether there is very low, low, moderate or high confidence in particular findings.

High confidence in the evidence base

We did not identify any factors as risk factors for gambling for any age group, or for harmful gambling in adults with a high degree of confidence.

We identified 4 factors as risk factors for subsequent harmful gambling for children and young people with a high degree of confidence. All were individual-level factors. These were:

- impulsivity (including sensation seeking)
- substance use
- gender (male)
- mental health problems (depression specifically)

This level of confidence was due to:

- the availability of a high-quality MA incorporating longitudinal evidence focused specifically on understanding risk factors for gambling among children and young people
- the number of primary studies included in the analysis
- consistent results across multiple reviews

Moderate confidence in the evidence base

We did not identify any factors as risk factors for gambling for any age group, or for harmful gambling in adults with a moderate degree of confidence.

We identified 6 factors that may be risk factors for harmful gambling for children and young people with moderate confidence.

The individual risk factors identified with moderate confidence for children and young people were:

- number of gambling activities participated in
- problem gambling severity
- anti-social behaviour
- violence
- poor academic performance

The only family and social factor identified with moderate confidence for children and young people was peer influences.

These were mostly identified through one high quality MA (15) but, as the number of primary studies included for each factor was low (5 studies or less) we considered it possible that new studies could affect the result.

Eight factors were considered not to be risk factors for harmful gambling in children and young people with a moderate degree of confidence. These include:

- money won or lost
- risk taking
- age and age of gambling onset
- religion
- aggression
- dispositional attention (reported under emotional regulation)
- some mental health problems (specifically anxiety, psychological distress, suicidal ideation and negative affect)

Again, we have moderate confidence in these results because of the high quality and coherent evidence presented in one MA, although with small numbers of studies (15).

Low confidence in the evidence base

We had low confidence that a further 24 factors could be risk factors for gambling or harmful gambling. This was because the reviews were of low quality and relied on cross-sectional studies (rather than longitudinal studies), meaning there are major methodological limitations and uncertainties about the quality of primary studies included in reviews. This is despite, in some cases, there being large numbers of reviews and primary studies, and coherent evidence of associations.

We considered 10 factors as potentially having an influence on gambling (see Table 11), but with low confidence. These were spread across multiple levels and age groups.

Table 11: Risk factors for gambling - low confidence in evidence base

	Individual	Family and social	Community	Societal
All age groups	• Ethnicity • Personal relative deprivation	No evidence	• Proximity to gambling opportunities • Density of gambling opportunities • Accessibility	Advertising and marketing
Adults only	Impulsivity (not sensation seeking)	No evidence	No evidence	No evidence
Children and young people only	• Socioeconomic status • Substance use	Peer influences	No evidence	No evidence

Similarly, we identified 15 factors that may influence harmful gambling (see Table 12) but again the extent of the associations is not yet clear. So, the level of confidence that these are risk factors for harmful gambling was low.

Table 12: Risk factors for harmful gambling - low confidence in evidence base

	Individual	Family and social	Community	Societal
All age groups	• Personal relative deprivation • ADHD • Ethnicity	Child maltreatment	Proximity to gambling opportunities	No evidence
Adults only	• Substance use • Impulsivity (not sensation seeking) • Trauma • Compulsivity • Emotional regulation • Neurological disorders treatment • Genetics • Gender	Peer influences	Accessibility	No evidence
Children and young people only	No evidence	No evidence	No evidence	No evidence

Also, the evidence suggests with low confidence that type of school attended is unlikely to be a risk factor harmful gambling.

Very low confidence and insufficient evidence

Finally, we identified a number of other factors within reviews (see table 13), but we cannot come to conclusions due to:

- very limited evidence on the potential impact on gambling or harmful gambling (for example, where a study was cited in a review, but not enough information was provided)
- conflicting evidence (for example family influence)
- where the relationship appeared to be bi-directional (for example mental health problems in adults)

There was also a complete absence of evidence for certain ages or population groups (see Table 14).

Table 13: Risk factors with very low confidence for gambling or harmful gambling

	Individual	Family and social	Community	Societal
All age groups	• Risk perception • Acculturation • Age • ADHD	• Social support • Family influences	Density of gambling opportunities	• Speed of play • Type of gambling activity
Adults only	• Marital status • Income • Employment • Mental health problems [a] • Age [a] • Socioeconomic status [a] • Ego strength [a] • Coping styles [a] • Cognitive distortions [a] • Physical health [a] • Gender	Intimate partner violence	No evidence	No evidence
Children and young people only	• Impulsivity • Money spent, lost or won	No evidence	No evidence	No evidence

Notes:
[a] Risk factors for harmful gambling

Table 14: Risk factors with no evidence for gambling or harmful gambling for certain age or population groups:

	Individual	Family and social	Community	Societal
All age groups	• Violence • Aggression • Acculturation [a] • Problem gambling severity • Trauma • Mental health problems • Emotional regulation • Compulsivity • Ego strength • Coping styles • Risk taking • Religion • Neurological disorders treatment • Antisocial behaviour • Number of gambling activities • Age of gambling onset	• Social support • Family influences	Density of gambling opportunities	• Speed of play • Type of gambling activity
Adults only	• Violence • Aggression • Problem gambling severity [a] • Money spent, lost or won [a] • Risk perception [a] • Risk taking [a] • Religion [a]	No evidence	No evidence	No evidence
Children and young	• Acculturation • Trauma [a] • Socioeconomic status [a]	No evidence	No evidence	No evidence

	Individual	Family and social	Community	Societal
people only	• Compulsivity [a] • Ego strength [a] • Coping styles • Neurological disorders treatment [a] • Physical health • Poor academic performance • Gender			

Notes:
[a] Risk factors for harmful gambling

Again, it is important to reiterate that relying on review-level evidence may have impeded our confidence ratings, as it is possible that primary studies are available that were not included in the reviews. Seven of the included reviews did not specify search dates. Ten reviews provided either no start date or no date restrictions, but for those that did, they varied widely, between 1970 and 2019.

4.3 Language and terminology

In undertaking this umbrella review, challenges emerged around the use of language or terms to describe gambling and some of the risk factors.

Given the lack of a clear definition of, or a universally agreed measurement tool for problematic gambling, the study took a broad-spectrum and inclusive approach to the evidence. We included reviews that explored gambling and problem gambling as well as gambling initiation or the escalation of gambling behaviour. Different studies used different thresholds for gambling at levels that cause harm, as well as different screening tools for gambling. The reliability of the measures used to assess risk factors also varied, which made it difficult to compare and analyse the existing data. Some MAs noted that studies used different:

- effect measures (for example risk ratios or odds ratios)
- methods of combining estimates (random or fixed effects models)
- approaches to handling missing data
- methods of assessing risk of bias

These factors mean it was not possible to adequately investigate our second research question ‘What risk factors are associated with different levels of gambling?’.

Similarly, there are overlaps in some of the risk factors we identified. For example, the term ‘accessibility’ is not well defined and overlaps with the concepts of ‘density’ and ‘proximity’. There was also some overlap for mental health problems, neurological disorders and some of the cognitive control and decision-making factors, such as impulsivity and compulsivity. There could also be an overlap between school type and academic performance. We decided to divide these up as separate risk factors to highlight their differences as potential risk factors across the socio-ecological model, but we could have taken alternative approaches to categorising these.

4.4 Gaps in the evidence

There is a lack of robust review-level evidence setting out risk factors for gambling for all age groups and harmful gambling among adult populations. All the risk factors identified with high confidence were taken from the only high-quality rated review (15), which related to children and young people only. To fill this gap in the evidence, a similar review of longitudinal evidence related to adults is urgently needed.

The available review-level evidence looked at mostly individual level risk factors for gambling, rather than family and peer group, community and societal levels. Evidence that does exist at these wider levels is mostly cross-sectional. This was reflected in the number of primary studies included in reviews, which also looked mostly at individual-level factors. This might be because the studies included in the reviews span 40 years, and it is only recently that the perception of gambling has changed. We are starting to see that gambling is likely to follow similar patterns to other public health issues (for example alcohol (89)) and is affected by wider determinants of health. So, there is a lack of research focus on these broader influences.

Our search only found one systematic review that looked explicitly at types of gambling activities. This was surprising particularly for online gambling, which has recently become more popular (7). This may be due to a lack of systematic review level evidence. We initially identified 2 reviews that looked at type of gambling activity, but we excluded both for not meeting the DARE criteria (90, 91). Since completing our review, an MA has been published (in February 2021, studies included between January 2012 and March 2019) examining risk factors for problem gambling and ranking the strength of risk based on 104 studies. This MA is limited by the inclusion of mostly cross-sectional evidence. But it does report strong and medium effect sizes for certain types of gambling (including internet gambling, electronic gaming machines and slot machines, daily lottery and sports betting) and small effect sizes for others (for example, weekly lottery). The strongest association between any risk factor and problem gambling was reported for internet gambling (OR 7.59, (95%CI: 5.24, 10.99) $p < 0.001$) (92).

4.5 Strengths and limitations

This umbrella review was based on rigorous systematic methods. We registered the review protocol before starting the review and we have reported deviations from the protocol, which were minor, in Appendix A. The identification and synthesis of systematic reviews, rather than primary studies, allowed us to identify a broad range of possible risk factors across multiple populations. We made an effort to focus on the best available evidence when reporting (for example, prioritising MAs, better quality reviews and those with larger numbers of studies). So, this review fulfils its aim of providing a comprehensive assessment of the potential risk factors associated with gambling.

That said, there are several limitations to this work. To ensure that the included reviews were systematic, we only included studies that met at least 4 of the 5 DARE criteria. However, this meant that some included reviews either had not conducted any risk of bias assessment or lacked sufficient details of included studies. Stricter inclusion criteria would have enabled a clearer and more robust synthesis but would have resulted in a loss of information.

Relying on systematic reviews means relying on how authors have reported and interpreted findings. We have already described the language-related challenges, but we encountered other issues during this review. We rely on the quality of the reviews' methods. With so many included reviews scoring critically low quality (using AMSTAR 2) it was difficult to conduct a reliable synthesis. There is also inevitable overlap in primary studies. While we were able to report on the extent of overlap at a high level in some sections, it is likely that the number of studies was double counted in some areas.

Most of the studies within the reviews were cross-sectional and only a small number were longitudinal studies. So, it was often not possible to be sure of the direction of causality. Including reviews of longitudinal studies would have identified more definitive risk factors. Also, we identified very little evidence from the UK. While we expect that evidence from OECD countries is transferable and applicable to the UK context, there will be some differences.

Although we identified a broad range of potential risk factors for harmful gambling, the nature of our review, being a review of reviews, meant that there may have been gaps. This is especially true for emerging evidence not yet systematically captured in other reviews.

4.6 Implications for research and policy

A broad range of factors are potentially associated with gambling and harmful gambling. While it has not been possible to determine the extent of causality for all possible risk factors, the associations reported here are important for understanding the extent to which gambling causes harm and when considering possible interventions. Structuring our work within the socio-ecological model allows us to better understand the factors that influence gambling. This includes the complex relationships between individual, family and social, community, and societal factors, and the effect of potential prevention strategies and interventions.

There is a need for a full systematic review of longitudinal studies examining risk factors for harmful gambling in adult populations. This would complement the review already conducted with a focus on children and young people (15). Also, new longitudinal primary studies are needed to address the gaps identified in our insufficient evidence section above. In particular, studies are needed to investigate environmental and societal influences and within the UK context. We appreciate that cross-sectional studies can be done with more ease and speed than longitudinal studies and are a useful step in first establishing whether there are associations between certain variables. But our review highlighted the need for an advance in the research undertaken in this field, namely moving away from cross-sectional research.

The AMSTAR 2 appraisal results make it clear that considerable improvements to reviews in this field are needed. For example, very few reviews explicitly stated that the review methods were established before conducting the review or justified any significant deviations from the protocol. Very few reviews used a satisfactory technique to assess risk of bias of the included studies. These are critical areas in the AMSTAR 2 tool. Only 2 reviews reported on the sources of funding for studies included in the review, which is important given the reliance on industry funding in this field (15, 64).

While more research is needed in many areas covered in this review, it has identified clearly several risk factors for both gambling and harmful gambling, especially risk factors for harmful gambling in young people. Many of these are at the individual level, some distal and some proximal, but most can be changed using interventions. With the growing concerns about the harm from gambling, these risk factors will be of interest to policy makers in future. Targeting these risk factors through preventative approaches rather than waiting until people need treatment and other frontline support services will help reduce gambling-related harm.

5. Conclusion

Understanding possible risk factors for gambling and for harmful gambling provides essential insight into what influences people to gamble, what can lead to it becoming a problem, for whom, and how it might best be tackled as a public health issue. The value of an umbrella review is that it can provide a wide overview of the evidence and can offer a useful reference for decision-makers. But it is also limited by the availability and quality of information included in the reviews.

While we identified a large number of potential risk factors, only a small number of reviews included longitudinal research. So, even though the many factors identified were associated with gambling or harmful gambling, it was not possible to say with confidence the extent to which they might cause or exacerbate the issue. The factors identified here will need careful consideration when scoping potential interventions to prevent gambling related harms in England.

Although further research is needed, this review provides a useful platform for understanding the range of potential risk factors for harmful gambling and developing a public health approach to reducing gambling-related harms.

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95. AMSTAR 2 - The new and improved AMSTAR

Appendix A: deviations from the protocol

The following changes were made to the protocol during the screening process.

New criteria for defining a systematic review

Definitions of systematic reviews vary widely (93). During screening the research team had difficulties determining which reviews to include and decided to set up stricter criteria.

The original protocol used the NICE glossary to define 'systematic review' as: "a review that summarises the evidence on a clearly formulated review question according to a predefined protocol, using systematic and explicit methods to identify, select and appraise relevant studies, and to extract, analyse, collate and report findings. It may or may not use statistical techniques, such as meta-analysis" (94). The protocol also stated that we would exclude types of review that did not report a methodology and those that did not synthesise the results of studies (for example scoping and mapping reviews).

Following discussion between the review team during the screening stage we decided to use the DARE criteria (30) to provide a more methodical and robust process for defining systematic reviews:

1 Were inclusion and exclusion criteria reported?
2 Was the search adequate?
3 Were the included studies synthesised?
4 Was the quality of the included studies assessed?
5 Are sufficient details about the individual included studies presented?

To be included, reviews had to meet at least 4 criteria with criteria 1 to 3 being mandatory

Agreeing on narrative reviews' main features

Narrative reviews typically summarise literature 'self-selected' by the authors. They may have no methods section at all or a short methods section detailing search terms, databases and key words. Some narrative reviews may also briefly specify inclusion criteria, but this is likely to be broad.

They may summarise the literature for a broad topic, without a focused research question, and the search may be equally broad. For example, in a review on adolescent gambling, the search terms might include some 'adolescent' terms and a

few ‘gambling’ terms, and the main narrative might describe the issue, prevalence, and risk and protective factors.

Structurally, a narrative review typically has a short introduction then a series of sub-headings similar to a book chapter, or a report. It may or may not have a methodology, if it does it will be a short paragraph.

Amending country criteria for clinical papers

We included clinical papers (for example, those that included genetic, biological, or psychological traits as risk factors) even if it was unclear whether they included papers from OECD countries. This was because we thought that these risk factors were unlikely to differ greatly according to country.

We increased proportion of studies to be double screened by the review team from 10% to 20%.

We added additional websites to the search for grey literature.

We consulted with the experts in our expert reference group to help us identify evidence not found through our search of the databases.

The full text of studies were screened by 2 reviewers rather than one.

Appendix B: Medline search

The below search terms were used to conduct a search in the Medline database. This is the full search conducted, to enable replication of our review.

1 gambl*.tw,kw.
2 (Iowa adj gambl*).tw,kw.
3 1 not 2
4 Gambling/
5 virtual good*.tw,kw.
6 (lottery or lotteries or lotto).tw,kw.
7 (scratchcard* or scratch card*).tw,kw.
8 in-game purchase*.tw,kw.
9 game credit*.tw,kw.
10 (loot box* or loot crate*).tw,kw.
11 slot machine*.tw,kw.
12 fruit machine*.tw,kw.
13 (video lottery or VLT).tw,kw.
14 casino*.tw,kw.
15 amusement arcade*.tw,kw.
16 microtransaction*.tw,kw.
17 (bingo not gene).tw,kw.
18 ((betting or bet or bets) and (horse* or racing or dog*)).tw,kw.
19 (game or games or gaming or gamer).tw,kw.
20 20. Video Games/
21 19 or 20
22 (money or monetization or monetisation or monetary or reward* or win or wins or winning* or loss or losses or lose).tw,kw.
23 exp Reward/
24 22 or 23
25 21 and 24
26 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17 or 18 or 25
27 risk factor*.tw,kw.
28 determinant*.tw,kw.
29 (exposure or exposed).tw,kw.
30 moderator.tw,kw.
31 mediator.tw,kw.

32 hazard*.tw,kw.
33 predictor*.tw,kw.
34 indicator*.tw,kw.
35 relationship*.tw,kw.
36 association*.tw,kw.
37 vulnerabilit*.tw,kw.
38 likelihood.tw,kw.
39 susceptibilit*.tw,kw.
40 risk factors/
41 Health Status Indicators/
42 27 or 28 or 29 or 30 or 31 or 32 or 33 or 34 or 35 or 36 or 37 or 38 or 39 or 40 or 41
43 26 and 42
44 limit 43 to English language
45 limit 44 to yr="2005 - 2019"
46 limit 45 to "reviews (maximizes sensitivity)"

Appendix C: Websites searched for grey literature

The websites searched for grey literature were:

- Gamble Aware InfoHub
- Gambling Commission
- GambLib (Gambling Research Library)
- Gam Care
- National Problem Gambling Clinic
- Gordon Moody Association
- Gamblers Anonymous
- Open Grey
- Gam-Anon
- Gambling Information Resource Office Research Library
- Advisory Board for Safer Gambling
- Gambling Watch UK
- Australian Gambling Research Centre
- Gambling Research Exchange Ontario
- Citizens Advice Bureau
- Be Gamble Aware
- Problem Gambling, Wigan Council
- Gambling Compliance
- Gambling Watch UK
- Child Family Community Australia
- International Centre for Youth Gambling Problems and High-Risk Behaviours
- Gambling and Addictions Research Centre
- Alberta Gambling Research Institute
- Responsible Gambling Council
- Problem Gambling Foundation of New Zealand
- Gambling Commission New Zealand
- Victorian Responsible Gambling Foundation

Appendix D: list of excluded papers and reason for their exclusion

Author (year)	Title	Reason to exclude
Barton (2017)	The effect of losses disguised as wins and near misses in electronic gaming machines: A systematic review	Focus is not risk factors
Beynon (2018)	Is gambling an emerging public health issue in Wales, UK? An assimilation of literature and data	Focus is not risk factors
Calado (2016)	Problem gambling worldwide: An update and systematic review of empirical research (2000-2015)	Focus is not risk factors
Calado (2017)	Prevalence of adolescent problem gambling: A systematic review of recent research	Focus is not risk factors
Calado (2017)	Prevalence of Adolescent Problem Gambling: A Systematic Review of Recent Research	Focus is not risk factors
Challet-Boujy (2017)	Cognitive remediation interventions for gambling disorder: A systematic review	Focus is not risk factors
Chebli (2016)	Internet-based interventions for addictive behaviours: A systematic review	Focus is not risk factors
Chretien (2017)	Cognitive restructuring of gambling-related thoughts: A systematic review	Focus is not risk factors
Cowlishaw (2012)	Psychological therapies for pathological and problem gambling	Focus is not risk factors
Dowling (2015)	The prevalence of comorbid personality disorders in treatment-seeking problem gamblers: A systematic review and meta-analysis	Focus is not risk factors

Author (year)	Title	Reason to exclude
Dowling (2016)	Problem Gambling and Intimate Partner Violence: A Systematic Review and Meta-Analysis	Focus is not risk factors
Drawson (2017)	The use of protective behavioural strategies in gambling: A systematic review	Focus is not risk factors
Forkus (2020)	Military Sexual Trauma and Risky Behaviors: A Systematic Review	Focus is not risk factors
Giroux (2017)	Online and mobile interventions for problem gambling, alcohol, and drugs: A systematic review	Focus is not risk factors
Goodie (2013)	Measuring cognitive distortions in pathological gambling: Review and meta-analyses	Focus is not risk factors
Gooding (2009)	A systematic review and meta-analysis of cognitive-behavioural interventions to reduce problem gambling: Hedging our bets?	Focus is not risk factors
Green (2020)	Avatar- and self-related processes and problematic gaming: A systematic review	Focus is not risk factors
Griffiths (2010)	Adolescent gambling on the internet: a review	Focus is not risk factors
Keen (2017)	Systematic Review of Empirically Evaluated School-Based Gambling Education Programs	Focus is not risk factors
King (2016)	Early exposure to digital simulated gambling: A review and conceptual model	Focus is not risk factors
King (2019)	Maladaptive player-game relationships in problematic gaming and gaming disorder: A systematic review	Focus is not risk factors
Kotter (2018)	A systematic review of land-based self-exclusion programs: Demographics, gambling behavior, gambling problems,	Focus is not risk factors

Author (year)	Title	Reason to exclude
	mental symptoms, and mental health	
Lipsizc (2010	Inhibitory control and psychopathology: A meta-analysis of studies using the stop signal task	Focus is not risk factors
Lopez-Fernandez (2020)	Preventing Harmful Internet Use-Related Addiction Problems in Europe: A Literature Review and Policy Options	Focus is not risk factors
Lorains (2011)	Prevalence of comorbid disorders in problem and pathological gambling: systematic review and meta-analysis of population surveys	Focus is not risk factors
Lucke (2006)	Assessment and management of pathological and problem gambling among older adults	Focus is not risk factors
Makani (2017)	Role of repetitive transcranial magnetic stimulation (rTMS) in treatment of addiction and related disorders: A systematic review	Focus is not risk factors
Nastally (2010)	Adolescent gambling: current trends in treatment and future directions	Focus is not risk factors
Petry (2017)	A systematic review of treatments for problem gambling	Focus is not risk factors
Sahu (2019)	Mobile Phone Addiction Among Children and Adolescents: A Systematic Review	Focus is not risk factors
Smith (2013)	Assessing randomised clinical trials of cognitive and exposure therapies for gambling disorders: A systematic review	Focus is not risk factors
Subramaniam (2015)	Prevalence and determinants of gambling disorder among older adults: a systematic review	Focus is not risk factors

Author (year)	Title	Reason to exclude
Tanner (2017)	Harm reduction in gambling: A systematic review of industry strategies	Focus is not risk factors
Uphoff (2013)	A systematic review of the relationships between social capital and socioeconomic inequalities in health: A contribution to understanding the psychosocial pathway of health inequalities	Focus is not risk factors
Wright (2012)	Impulse-control disorders in Gilles de la Tourette syndrome	Focus is not risk factors
Yakovenko (2015)	The efficacy of motivational interviewing for disordered gambling: Systematic review and meta-analysis	Focus is not risk factors
Chamberlain (2019)	Impulsivity and disordered gambling: An introduction and update	Full text not available
Chhibber (2019)	Impulse control disorders associated with dopamine agonists in patients with prolactinomas: A literature review	Full text not available
Rogier (2019)	State of the art of studies investigating the relationship between Emotion Regulation and Gambling Disorder: Preliminary results from a systematic review study	Full text not available
Barake 2018	Management of endocrine disease: Impulse control disorders in patients with hyperpolactinemia treated with dopamine agonists: how much should we worry?	Outcomes are incorrect
Ceravolo (2010)	Impulse control disorders in Parkinson's disease: definition, epidemiology, risk factors, neurobiology and management	Outcomes are incorrect

Author (year)	Title	Reason to exclude
Karaca (2016)	Comorbidity between behavioral addictions and attention deficit/hyperactivity disorder: A systematic review	Outcomes are incorrect
King (2020)	The convergence of gambling and monetised gaming activities	Outcomes are incorrect
Konkoly (2017)	Relationship between interpersonal trauma exposure and addictive behaviors: A systematic review	Outcomes are incorrect
Konkoly 2017	Relationship between interpersonal trauma exposure and addictive behaviors: A systematic review	Outcomes are incorrect
Latella (2019)	Impulse control disorders in Parkinson's disease: A systematic review on risk factors and pathophysiology	Outcomes are incorrect
Skidmore (2015)	Substance-related and addictive disorders: Diagnosis, comorbidity, and psychopathology	Outcomes are incorrect
Abbott (2020)	The changing epidemiology of gambling disorder and gambling-related harm: public health implications	Study type is incorrect
Ariyabuddhiphongs (2011)	Lottery gambling: a review	Study type is incorrect
Ariyabuddhiphongs (2013)	Adolescent gambling: A narrative review of behavior and its predictors	Study type is incorrect
Armstrong (2018)	An Exploration of How Simulated Gambling Games May Promote Gambling with Money	Study type is incorrect
Arthur (2016)	The conceptual and empirical relationship between gambling, investing, and speculation	Study type is incorrect
Atherton (2019)	Is gambling an emerging public health issue for Wales, UK?	Study type is incorrect

Author (year)	Title	Reason to exclude
Balodis (2020)	Common neurobiological and psychological underpinnings of gambling and substance-use disorders	Study type is incorrect
Barns (2010)	The prevalence and clinical characteristics of pathological gambling in Parkinson's disease: an evidence-based review	Study type is incorrect
Barns (2011)	The prevalence and clinical characteristics of pathological gambling in patients with Parkinson's disease: An evidence based review	Study type is incorrect
Bertrand (2008)	Adapted couple therapy (ACT) for pathological gamblers: A promising avenue	Study type is incorrect
Breen (2013)	Aboriginal gambling and problem gambling: A review	Study type is incorrect
Brewer (2008)	The neurobiology and genetics of impulse control disorders: relationships to drug addictions	Study type is incorrect
Brown (2015)	The Application of an Etiological Model of Personality Disorders to Problem Gambling	Study type is incorrect
Browne (2018)	Prevalence of gambling-related harm provides evidence for the prevention paradox	Study type is incorrect
Cavanna (2012)	Psychology of gambling: New research	Study type is incorrect
Ceravolo (2010)	Spectrum of addictions in Parkinson's disease: from dopamine dysregulation syndrome to impulse control disorders	Study type is incorrect
Conversano (2012)	Pathological gambling: a systematic review of biochemical, neuroimaging, and neuropsychological findings	Study type is incorrect

Author (year)	Title	Reason to exclude
Cowen (2018)	Online gambling: addicted to addiction	Study type is incorrect
Dash (2019)	Big Five personality traits and alcohol, nicotine, cannabis, and gambling disorder comorbidity	Study type is incorrect
Delfabbro (2012)	Behavioural profiling of problem gamblers: A summary and review	Study type is incorrect
Dell'Osso (2006)	Epidemiologic and clinical updates on impulse control disorders: a critical review	Study type is incorrect
Derevensky (2019)	Problem gambling and associated mental health concerns in elite athletes: a narrative review	Study type is incorrect
Derevensky (2019)	Behavioral Addictions: Excessive Gambling, Gaming, Internet, and Smartphone Use Among Children and Adolescents	Study type is incorrect
Destoop (2019)	Addiction, Anhedonia, and Comorbid Mood Disorder. A Narrative Review	Study type is incorrect
Djamshidian (2011)	Pathological gambling in Parkinson's disease--a review of the literature	Study type is incorrect
Dowling (2005)	Electronic gaming machines: are they the 'crack-cocaine' of gambling?	Study type is incorrect
Fattore (2014)	Sex differences in addictive disorders	Study type is incorrect
Ferentzy (2009)	Gambling and organized crime-A review of the literature	Study type is incorrect
Ferentzy (2013)	Illicit drug use and problem gambling	Study type is incorrect
Floros (2018)	Gambling disorder in adolescents: Prevalence, new developments, and treatment challenges	Study type is incorrect
Folino (2009)	Pathological gambling and criminality	Study type is incorrect

Author (year)	Title	Reason to exclude
French (2008)	Drinkers and bettors: investigating the complementarity of alcohol consumption and problem gambling	Study type is incorrect
Gainsbury (2015)	Online Gambling Addiction: the Relationship Between Internet Gambling and Disordered Gambling	Study type is incorrect
Gallagher (2007)	Pathological gambling in Parkinson's disease: risk factors and differences from dopamine dysregulation. An analysis of published case series	Study type is incorrect
Goodie and Fortune (2013)	Measuring cognitive distortions in pathological gambling: review and meta-analyses	Study type is incorrect
Heiden (2017)	Pathological gambling in Parkinson's disease: what are the risk factors and what is the role of impulsivity?	Study type is incorrect
Hinvest (2012)	Prevention is better than cure. Vulnerability markers for problem gambling	Study type is incorrect
Jauregui (2016)	Pathological Gambling and Associated Drug and Alcohol Abuse, Emotion Regulation, and Anxious-Depressive Symptomatology	Study type is incorrect
Johansson (2009)	Risk factors for problematic gambling: a critical literature review	Study type is incorrect
King (2010)	The convergence of gambling and digital media: implications for gambling in young people	Study type is incorrect
Kraplin (2018)	Characteristics and risk factors of gambling disorder as basis for responsible gambling strategies	Study type is incorrect
Kuss, 2012	Internet gambling addiction	Study type is incorrect

Author (year)	Title	Reason to exclude
Lader (2008)	Antiparkinsonian medication and pathological gambling	Study type is incorrect
Lawn (2020)	A Literature Review and Gap Analysis of Emerging Technologies and New Trends in Gambling	Study type is incorrect
Lee (2019)	A Systematic Meta-Review of Impulsivity and Compulsivity in Addictive Behaviors	Study type is incorrect
Leeman (2012)	Similarities and differences between pathological gambling and substance use disorders: a focus on impulsivity and compulsivity	Study type is incorrect
Linnet (2020)	The anticipatory dopamine response in addiction: A common neurobiological underpinning of gambling disorder and substance use disorder?	Study type is incorrect
Lobo (2006)	The genetics of gambling and behavioral addictions	Study type is incorrect
Lobo (2009)	Genetic aspects of pathological gambling: a complex disorder with shared genetic vulnerabilities	Study type is incorrect
Lopez-Gonzalez (2017)	Marketing and Advertising Online Sports Betting: A Problem Gambling Perspective	Study type is incorrect
MacLaren (2016)	Video Lottery is the Most Harmful Form of Gambling in Canada	Study type is incorrect
Maloney (2017)	Phenomenology and epidemiology of impulsive-compulsive behaviours in Parkinson's disease, atypical Parkinsonian disorders and non-Parkinsonian populations	Study type is incorrect
Markham (2017)	A meta-regression analysis of 41 Australian problem gambling prevalence estimates and their	Study type is incorrect

Author (year)	Title	Reason to exclude
	relationship to total spending on electronic gaming machines	
McGrath (2009)	The comorbidity of tobacco smoking and gambling: a review of the literature	Study type is incorrect
McKay (2005)	Double Jeopardy: Older Women and Problem Gambling	Study type is incorrect
Messerlian (2007)	Beyond drugs and alcohol: Including gambling in a high-risk behavioural framework	Study type is incorrect
Mestre-Bach (2020)	Emotional regulation in gambling disorder	Study type is incorrect
Momper (2010)	Implications of American Indian gambling for social work research and practice	Study type is incorrect
Nautiyal (2017)	Gambling disorder: an integrative review of animal and human studies	Study type is incorrect
Nowak (2018)	Gambling disorder in the college student-athlete population: An overview	Study type is incorrect
Okuda (2016)	Gambling Disorder and Minority Populations: Prevalence and Risk Factors	Study type is incorrect
Olley (2015)	Dopaminergic Medication in Parkinson's Disease and Problem Gambling	Study type is incorrect
Paris (2010)	Sex differences in salivary cortisol in response to acute stressors among healthy participants, in recreational or pathological gamblers, and in those with posttraumatic stress disorder	Study type is incorrect
Paterson (2020)	Exploring the prevalence of gambling harm among active duty military personnel: a systematic scoping review	Study type is incorrect

Author (year)	Title	Reason to exclude
Petry (2005)	Prevention: Focus on gambling in youth and young adults	Study type is incorrect
Petry (2005)	Cognitive biases and cognitive therapy	Study type is incorrect
Petry (2005)	Comorbidity of disordered gambling and other psychiatric disorders	Study type is incorrect
Petry (2007)	Gambling and substance use disorders: current status and future directions	Study type is incorrect
Petry (2010)	Discounting and pathological gambling	Study type is incorrect
Pirritano (2014)	Gambling disorder during dopamine replacement treatment in Parkinson's disease: a comprehensive review	Study type is incorrect
Potenza (2019)	Gambling disorder	Study type is incorrect
Prelipceanu (2005)	Pathological gambling - A modern approach	Study type is incorrect
Rogier (2018)	Conceptualizing gambling disorder with the process model of emotion regulation	Study type is incorrect
Ruiz (2020)	Psychobiology of gambling-related cognitions in gambling disorder	Study type is incorrect
Santangelo (2013)	Pathological gambling in Parkinson's disease. A comprehensive review	Study type is incorrect
Secades-Villa (2016)	The Relationship between Impulsivity and Problem Gambling in Adolescence	Study type is incorrect
Sesar (2018)	Mental health of perpetrators of intimate partner violence	Study type is incorrect
Shaffer (2011)	Disordered gambling: etiology, trajectory, and clinical considerations	Study type is incorrect

Author (year)	Title	Reason to exclude
Shaffer (2014)	Psychiatric epidemiology, nosology, and treatment: Considering Internet gambling	Study type is incorrect
Sharman (2019)	Psychosocial risk factors in disordered gambling: A descriptive systematic overview of vulnerable populations	Study type is incorrect
Shead (2010)	Risk and protective factors associated with youth problem gambling	Study type is incorrect
Stenstrom (2011)	Testosterone, financial risk-taking, and pathological gambling	Study type is incorrect
Sulkunnen (2019)	The effects of changing availability	Study type is incorrect
Swanton (2020)	Gambling-related consumer credit use and debt problems: a brief review	Study type is incorrect
Tirachaimongkol (2010)	Pathways to problem gambling in seniors	Study type is incorrect
Torta (2008)	Reward pathways in Parkinson's disease: clinical and theoretical implications	Study type is incorrect
Tse, 2012	Gambling behavior and problems among older adults: a systematic review of empirical studies	Study type is incorrect
Turchi (2006)	Youth gambling: not a safe bet	Study type is incorrect
Vaddiparti (2017)	Personality disorders and pathological gambling	Study type is incorrect
van den Bos (2013)	Cross-species approaches to pathological gambling: a review targeting sex differences, adolescent vulnerability and ecological validity of research tools	Study type is incorrect
Vargas (2018)	Impulse control and related disorders in Parkinson's disease	Study type is incorrect

Author (year)	Title	Reason to exclude
Volberg (2010)	An international perspective on youth gambling prevalence studies	Study type is incorrect
Wenzel (2009)	Female pathological gamblers. A critical review of the clinical findings. International Journal of Mental Health and Addiction	Study type is incorrect
Whiting (2016)	Investigating Veterans' Pre-, Peri-, and Post-Deployment Experiences as Potential Risk Factors for Problem Gambling	Study type is incorrect
Wick (2012)	High-stakes gambling: Seniors may be the losers	Study type is incorrect
Wiehler (2015)	Reward-based decision making in pathological gambling: the roles of risk and delay	Study type is incorrect
Williams (2007)	Prevention of Problem Gambling: A Comprehensive Review of the Evidence	Study type is incorrect
Winters (2019)	A Review of Sports Wagering: Prevalence, Characteristics of Sports Bettors, and Association with Problem Gambling	Study type is incorrect
Wohl (2017)	An examination of the relationship between social casino gaming and gambling: The bad, the ugly, and the good	Study type is incorrect
Abbott (2018)	Conceptual Framework of Harmful Gambling: an international collaboration	Study type is incorrect

Appendix E: duplicate primary studies within the included reviews

1. Afifi, T.O., Brownridge, D.A., MacMillan, H., Sareen, J., The relationship of gambling to intimate partner violence and child maltreatment in a nationally representative sample (2010) Journal of Psychiatric Research, 44 (5), pp. 331-337
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Appendix F: AMSTAR 2 quality assessment

AMSTAR 2 is a 16-item critical appraisal tool for systematic reviews that include randomised or non-randomised studies of healthcare interventions, or both.

Items are considered critical or non-critical, depending on the review type. AMSTAR 2 is not designed to generate an overall 'score' (a high score may disguise critical weaknesses in specific domains, such as an inadequate literature search or a failure to assess risk of bias with individual studies that were included in a systematic review). In making an overall rating of a systematic review it is important to take account of flaws in critical domains, which may greatly weaken the confidence that can be placed in a systematic review. The overall rating is based on weaknesses in critical domains. (95)

A flaw is recorded against each item a review fails to satisfy completely. Partial consideration of an item is considered a non-critical flaw.

Rating overall confidence in the results of the review

High

No or one non-critical weakness. The systematic review provides an accurate and comprehensive summary of the results of the available studies that address the question of interest.

Moderate

More than one non-critical weakness. The systematic review has more than one weakness but no critical flaws. It may provide an accurate summary of the results of the available studies that were included in the review.

Low

One critical flaw with or without non-critical weaknesses. The review may not provide an accurate and comprehensive summary of the available studies that address the question of interest.

Critically low

More than one critical flaw with or without non-critical weaknesses. The review should not be relied on to provide an accurate and comprehensive summary of the available studies

Appendix G: review team and expert reference group

The review team members and their organisational affiliations were:

- Caryl Beynon, Public Health England
- Rachel Clark, Public Health England
- Zoe Clarke, Public Health England
- Mary Gatineau, Public Health England
- Felix Greaves, Public Health England
- Clive Henn, Public Health England
- Alyson Jones, Public Health England
- Jenny Mason, Public Health England
- Nicola Pearce-Smith, Public Health England
- John Marsden, King's College London
- Marguerite Regan, Public Health England

Expert reference group members were:

- Professor Charles Livingstone, Monash University, Australia
- Professor Linda Davies, Manchester University
- Professor Kathryn Oliver, LSHTM
- Dr Dimitrinka Atanasova, Lancaster University
- Professor Luke Clark, University of British Columbia, Canada
- Professor Jim Orford, University of Birmingham
- Dr Andrew Booth, Sheffield University
- Dr Anna van der Gaag, University of Surrey and Chair of the Advisory board for safer gambling

About Public Health England

Public Health England exists to protect and improve the nation's health and wellbeing, and reduce health inequalities. We do this through world-leading science, research, knowledge and intelligence, advocacy, partnerships and the delivery of specialist public health services. We are an executive agency of the Department of Health and Social Care, and a distinct delivery organisation with operational autonomy. We provide government, local government, the NHS, Parliament, industry and the public with evidence-based professional, scientific and delivery expertise and support.

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